

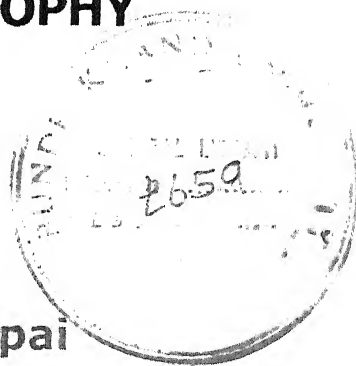
Effects of
Sulphate polymer
EXTRACT ON MATZE CROP

**THESIS
SUBMITTED TO
THE BUNDELKHAND UNIVERSITY, JHANSI**



**FOR THE DEGREE OF
DOCTOR IN PHILOSOPHY
IN
BOTANY**

**By
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M.Sc. (Botany)**



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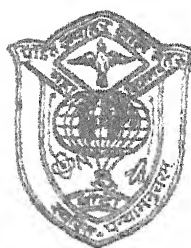
*Dedicated in the loving
memory of my father
Late Sri Maheshwari Prasad Bajpai*

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C E R T I F I C A T E

This is to certify that Mr. Kishor Kumar Bajpai of Pt. Jawaharlal Nehru P.G. College, Banda has worked under my supervision on the problem "**EFFECTS OF *Spirodella polyrhiza* EXTRACTS ON MAIZE CROP**" for the degree of **Doctor of Philosophy** of Bundelkhand University, Jhansi. The accompanying thesis presented embodies the work of candidate himself carried out in well over 200 days.

(A.K. AWASTHI)

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Banda, Thursday, 5 Dec., 2002

Kishor Kumar Bajpai

Kishor Kumar Bajpai

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PREFACE

PREFACE

Tropical and subtropical regions of the world support rapid spread of aquatic weeds and aroused growing concern vis-a-vis abnoxious attributes. They attracted attention for exploration and enquiry and how best they could benefit mankind. Weed problem is global but no where it occupies greater relevance as in South-East Asia, moreso, India. Encroachment of aquatic weeds in varied environments has created socio-economic problems. India is particularly vulnerable due to wide spread of aquatic weeds.

Out of Indian aquatic vegetation ten common weeds including *Spirodella polyrhiza* are well known as noxious weeds. *Spirodella polyrhiza* is free floating minute plant distributed in seventy seven districts of India and causes concern in forty six districts. It impounds water, retards growth of cultivated plants, makes water impotable, increases loss of water, causes disease problems and provides hinderance to aquatic sports and fisheries.

Hillman (1961) while reviewing the research work concerned with Lemnaceae has pointed out areas of futurestic research. Some of the areas needing attention included : Precise repetition of experiments depends on the use of the same

clone, medium, stock conditions and experimental period, among other factors. Trace metal nutrition, pH and other medium variables change with time in culture, may interact in a complex fashion, and should not be left entirely to untested assumptions in a given series of experiments; plants from older cultures may differ from those in younger cultures in many respects. Increase in frond number is exponential under good culture conditions, but is not analogous to the growth of microorganisms by simple division. Annual cycles in frond multiplication rate and other growth values under constant light and temperature have been reported, but require confirmation under conditions controlling as many other variables (e.g., air pollution) as possible. Certain species are able to grow in darkness if supplied with minerals and sucrose; others will not do so unless given additional supplements or low doses of red light- Roots do not elongate except under normal light conditions. The nature of these dark-induced blocks in growth is unknown. Growth in aseptic culture is often promoted by the addition of organic compounds to the basic mineral medium. Sugars promote growth only under suboptimal light supply. Many other compounds may promote growth by improving trace-element availability as complexes, or buffering pH changes. The question whether such compounds would promote growth under optimal conditions of light, temperature

and inorganic nutrition remains unanswered. The cycle of "Senescence and rejuvenation" in vegetative, reproductive, and its modification by external factors, offer an excellent model system for the study of aging. It is also an important consideration in any other study in which small numbers of individuals are used. However, Hillman also could not coin the idea of utilizing lemnoids as source for obtaining extracts containing growth substances to boost growth and yield of crop plants. Present investigation is aimed to fill part of this vacuum in the existing knowledge of lemnoids.

The minute size of *Spirodella polyrhiza* coupled with all attributes of an angiosperm, ease of in vitro culture and possibility for experimental manoeuvring of complete plant accrues considerable significance to it as an ideal experimental material for its *in vitro* mass culture to serve as a source for obtaining extracts containing growth substances.

Maize is one of the most important cereal crop in the world agricultural economy and is rated next to wheat and rice. It is highly responsive to favourable environment, better crop management and its superior physiological efficiency explicits itself in the highest average grain yield production amongst cereals. It is suited to a much wider range of climatic conditions than either wheat or rice. The

crop is grown in different continents of Africa, North-Central America, South America, Europe and Asia. Maize is cultivated in United States of America, China, Russia and many of the South-East Asian countries as a major crop. India stands fifth in terms of world acreage only next to U.S.A., Brazil, China and Mexico. However, India ranks tenth in world production of maize. In Asia, India is next only to China and accounts for 23 percent of the total area and 13 percent of the total production.

World maize acreage is close in approximation with rice which forms principal food of nearly half of mankind but its production and yield at times surpasses that of rice. It is interesting to note that a correlation of cultivated area and production of maize in North-central America and Asia indicates that yield and production of maize in latter is far less than that in former. India produces 6,804,000 tons of maize from cultivated area extending 5,983,000 hectare.

Even such a wide scale cultivation of maize in India presents a low average yield and is inadequate to meet nation's demand. The reason for such a poor yield besides lack of proper irrigation facilities and control of pests and diseases is scanty knowledge of scientific methods to augment increase in productivity of the crop under Indian conditions. There is

as such a need for keeping alive a spirit of investigation in frontiers of knowledge to evolve and understand various aspects relating to growth and yield of the crop dependent largely on its metabolism and anatomy apart from climatic factors

Estimated trends of *Spirodella polyrhiza* infestation are suggestive of increase in majority of districts or else infestation remains atleast constant but a decline has been scarcely reported. Naturally, such luxuriance of *Spirodella polyrhiza* infestation coupled with attributes referred to earlier appeared proven with possibilities to study effect of *Spirodella polyrhiza* extracts on anatomy, growth, development, chemical constituents and productivity of maize crop. How best this knowledge can be used to benefit mankind forms the basic theme of this thesis.

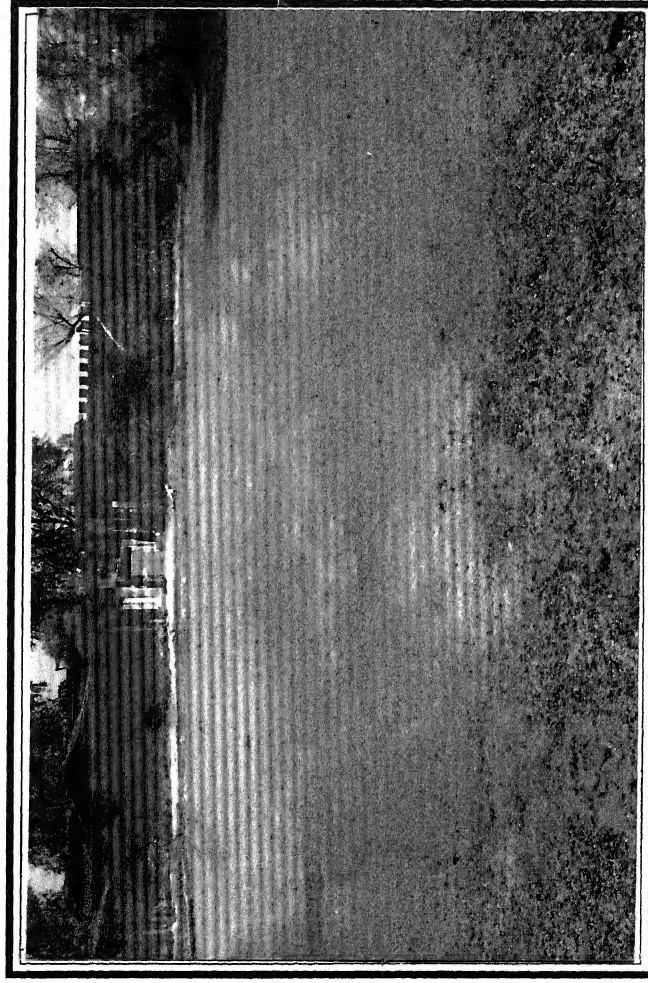
INTRODUCTION

INTRODUCTION

The dynamic features of aquatic habitats in South-East Asia in general and India in particular have supported luxuriant growth of aquatic weeds. Studies have been made for their utilization in multiple ways in developing countries. Aquatic weeds are known to cause problems of varied nature like covering of impounded water, hindrance to fisheries, choking of flowing waters, suppressing growth of cultivated plants, making water impotable, increased loss of water, create disease problems, impediment to navigation and hindrance to aquatic sports. Besides such problems, they also supplement as source of fodder, green manure and fish food. In view of the significance of noxious aquatic vegetation, a general consciousness among scientists working in different regions of South-East Asia was evolved to pinpoint problems associated with vast community of aquatic plants and to explore possibilities of their utilization for the benefit of mankind.

Out of variety of aquatic plants, *S. polyrhiza* comprises simplest and smallest of flowering plants relegated as botanical curiosity. They have been described as plants without known economic significance in the beginning but now their relevance as fish and duck food has attracted attention. Nowinska and

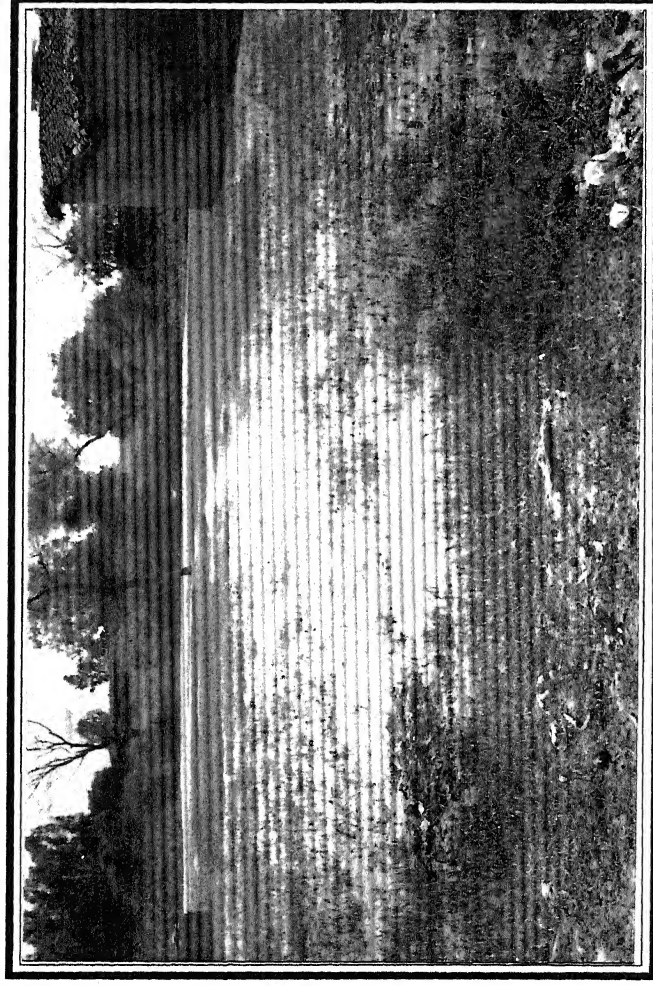
PHOTO -1: SHOWING PROFUSE GROWTH OF *Spirodella polyrhiza* IN CHHABI TALAB POND AT
KAILASHPURI, BANDA.



Rzeska (1972) pointed out the importance of *Wolffia arrhiza* as a poor man's food for Polish, Burmese and Thai people. They reported an estimated yield of 265 tonnes of green matter per hectare and 2080 kg of protein per hectare. There are also reports of endogenous gibberellins in floating plants and turions of *Wolffia floridana* (Pieterse, Bhalla and Sabharwal, 1971) also evidence for growth-promoting and inhibitory substances in extracts of variety of plant materials (Matzger and Zeevaart, 1980; Albane *et al.*, 1984; Pontovich *et al.*, 1984; Ahokas, 1985; Gaskin *et al.*, 1985; Janaki and William, 1986; James and Marcia, 1986 and Prudence *et al.*, 1986). Lemnoids like *Spirodella polyrhiza* also serve for extraction of growth substances for utilization in agriculture. A closer examination of various aspects linked with another lemnoideid, *S. polyrhiza* would be of interest to depict totality of their significance as mentioned below.

The duckweeds have been rated among ten major noxious weeds (Varshney and Singh, 1973) causing major problems in forty six districts, out of their total occurrence in 77 districts in India. It is interesting to remark that estimated trends of duckweed infestations increased in 12 districts, a decline is marked only in one while in 8 districts a constant growth manifests. It may, thus, be concluded that lemnoideids harbour

PHOTO - 2: SHOWING PROFUSE GROWTH OF *Spirodella polyrhiza* IN TINDWARI ROAD, KALU KUNWA,
BANDA.



increased distribution and are potentially useful for their multiple values. The growth, distribution and periodicity of duckweeds of Kanpur were studied with a view to emphasis their significance earlier by Shukla and Pandey (1979) and Awasthi and Shukla (1989). A preliminary survey on the distribution of aquatic angiosperms of Bundelkhand has been done by Tripathi and Awasthi (2001).

Lemnoids are endowed with particular features which place them above par organisms like fruitflies and breadmolds for simplicity in their structures and small size. They are of distinct advantage over microorganisms as a tool to unravel basic mysteries of growth and metabolism of higher plants. The lemnoids exhibit vegetative propagation as major means of reproduction through formation of clones. This multiplies their utility in genetic research for single clone experiments beset with prospects of elimination of genetic variability. The structural similarity, homogeneity and ease of *in vitro* culture could be well exploited for obtaining extracts containing growth substances to study their effects on maize crop.

Studies to understand mysteries of growth and development of plants have attracted the attention of plant physiologists since very early times. The knowledge of hormonal control of plant growth during recent years has replaced the earlier view

that for proper growth of plants adequate environmental conditions with balanced supply of nutrients are enough. It has been recognised that plant growth is not only dependent on intake of inorganic substances but is controlled and coordinated by certain organic substances produced by the plant itself. These substances are popularly known as growth regulators including auxins, gibberellins, kinins and other growth promoting substances. Similar effect has been found on plant growth by application of certain synthetic substances. Application of growth regulators to various plants has not only provided a better understanding of various physiological processes of plants but also has far-reaching agricultural and horticultural values.

The extensive literature dealing with heterogenous responses of plants to growth regulation has been reviewed by Wort (1949, 1951, 1952); Sircar (1963); Leopold (1964) and others. Most of the investigations relate to the application of hormones as sprays and only a few references are available dealing with the influence of pre-treatment of seeds by these substances.

The effect of growth regulating substances on seedling growth has been investigated by several workers. Studies on the effect of IAA on certain members of Cruciferae (Garrard, 1954); NAA on maize (Paliwal, 1959); IAA on intact wheat

seedlings (Pratt and Robertson, 1938) have been made.

Exhaustive literature on utilization of algal extracts to promote seedling growth and development following treatment with extracts of *Phormidium foveolarum* in rice (Gupta and Shukla, 1964, 1969); Wheat (Kushwaha and Gupta, 1970a, 1970b, Awasthi, 1983) and *Vigna Catjana* (Gupta and Gupta, 1970) is available. Effect of water hyacinth root extracts on rice growth and productivity has also been reported elsewhere (Sircar, 1963).

The response of various synthetic hormones in regulating vegetative growth and the yield of plant has been investigated in some detail on a variety of plants (McRostie, Hopkins and Grace, 1938; Hopkins, 1940; Wort, 1949; Bharadwaj and Rao, 1956; Stowe and Yamaki, 1957; Brian, 1959, Stewart and Shantz, 1959, Awasthi and Shukla, 1985; 1989). The literature dealing with response of these substances on growth and development may either be stimulatory or inhibitory depending upon nature of hormone and the the treatments.

There has been fruitful research on effect of plant extracts on growth and development of crop plants (Shukla, 1982; 1985). Existence of growth promoting substances in plant extracts has also been well documented. In addition to fungi and bacteria a number of higher plants have been reported

to contain gibberellins (Katzenelson, Sirosis and Cole, 1962; Brian, Hemming and Lowe; 1964; Maheshwari and Bhatia 1966; Iwahori, Weaver and Pool, 1968; Jennings, 1968; Jones and Lang 1968; Proanao and Greene 1968. Gibberellins have also been reported from marine algae (Mowat, 1963; Jennings and McComb 1967; Jennings; 1968 and Jones and Lang, 1968). Likewise gibberellin like substance has been reported in extracts of *Phormidium foveolarum* (Gupta and Shukla, 1967; Gupta and Agarwal, 1973). Literature also supports existence of gibberellin like substance in watermelon seeds (Bhalla, 1971). Response of rice crop to pre-soaking seed treatment and spraying with algal extracts in growth, development, yield and protein contents has been reported elsewhere (Shukla and Gupta, 1967; Gupta and Shukla, 1964, 1967, 1969; Shukla, 1968; 1975a). Effects of pre-soaking seed treatment and spraying with low concentrations of algal extracts has shown remarkable boost in rice productivity, yield and protein-content of rice plants under green house conditions (Shukla, 1972; 1975a). Field trials conducted to ascertain response of rice to *Phormidium foveolarum* and *P. tenue* extracts showed considerable increased growth and development of rice plants (Shukla, 1982). Influence of algal extracts on growth and yield of other crop plants like wheat (Kushwaha and Gupta, 1970a, b; Gupta and Kushwaha, 1972), *Vigna catzang* (Gupta and

Gupta, 1970; 1973) and *Phaseolus aureus* (Gupta and Gupta, 1972) has also been studied. Effects of *Lemna paucicostata* extracts on growth, yield, development and chemical composition of barley plants has been reported (Pandey, 1979). Response of rice plants to algal extracts with reference to certain plant metabolites and some aspects of plant metabolism have also been studied (Shukla, 1968). The topic on effects of algal growth substances has been reviewed (Shukla, 1985).

Effects of water hyacinth extracts on growth and development of rice plants has been extensively studied (Sircar and Kundu, 1960; Sircar, 1963). Effects of *Lemna paucicostata* extracts on growth, yield and composition of barley (Pandey, 1979); maize (Shukla and Agnihotri, 1983); wheat plants (Shukla and Gummundi, 1981) have been reported. Response of rice plants to algal (Shukla, 1968) and water hyacinth (Sircar, 1963) extracts with special reference to certain plant metabolites and some aspects of plant of plant metabolism have also been studied. Effects of *Wolffia arrhiza* extracts on growth and development of wheat plant also has been reported by Awasthi (1986).

Studies of Thimann (1949) suggested that respiratory activity has a vital correlation with growth patterns and has presented evidence that growth is limited through a respiratory

enzyme of sulphahydryl nature. The influence of growth regulators on respiration has been investigated and the effect of 2, 4-D on wheat and mustard (Taylor, 1947); maize (Sinha, 1957) and bind weed tissue (Smith, Hamner and Carlson, 1947); showed change in respiratory rates. Similarly effect of IAA on respiration of intact wheat seedlings has been observed (Pratt and Robertson, 1938).

Treatment with water extracts of *P. foveolarum* has been found to promote rate of respiration. Treatment with water extract has a stimulatory effects at 72 hrs in contrast to the depressing effect observed with ether extract suspended in water (Shukla, 1968).

The amount of carbon dioxide liberation goes hand in hand with oxygen consumed during respiration. However, at 72 hrs, treatment with 0.5 percent increase carbon dioxide output to maximum extent. Results suggest that during subsequent observations made up to 144 hrs, the rate of respiration continues to increase in normal untreated seedlings (Shukla, 1968).

There are reports of increases in chlorophyll contents of *L. paucicostata* following supplies of DTPA, BIMDA, Vitamin B, Glycine, Morphectin and EDTA but IAA, GA and 2, 4-D depress the pigment content (Pandey, 1979).

Application of growth regulators has been found to effect nitrogen and protein contents in various plants. A substantial increase in nitrogen and protein contents following hormone treatments has been reported by Sell, Luecke, Taylor and Hamner (1949); Dunham (1951) and Pande (1954). Treatment on bean (Weller, Luecke, Hamner and Sell, 1950) and potato plants (Payne, Fults and Hay, 1952) with 2, 4-D decreased nitrogen and protein contents. Results obtained suggested that percentage of nitrogen and protein may be controlled and coordinated by application of suitable hormone or extracts containing growth substances.

The final effect of hormone treatment depends upon kind of hormone, developmental stage of the plant at which the hormone is applied, its past history at the time of treatment, concentration of the hormone applied and the environmental conditions in post-application period (Wort, 1962).

Sugar and starch contents in seeds of cereals determine the quality of produce and its nutritive value. Application of 2, 4-D and NAA in maize seedlings have been reported. Changes in such contents in other crops with hormonal applications have been reported elsewhere (Wort, 1962).

Despite abundance of literature concerned with anatomy of various plants there is a dearth of literature concerned with

influence of growth promoting substances on anatomy of various plant systems. However, works of Torrey (1953); Roberts (1960); Kennedy and Farrar (1965); Cronshaw and Morey (1965); Morey and Cronshaw (1966); Morey (1968a); (1968b) and Maurya (1983) deal with influence of growth substances on anatomical structures elsewhere. Response of plants to growth substances in extracts with special reference to anatomy has been very little known (Maurya, 1983 and Awasthi and Shukla, 1986).

There are only causal reports on anatomical effects of algal extracts on epidermal and stomatal development in rice (Shukla, 1969) and wheat leaves (Shukla, 1975b). Effects of certain synthetic growth substances on stomatal and epidermal development of maize leaves have been reported earlier (Shukla and Shukla, 1975). Effect of *Wolffia arrhiza* extracts on stomatal and epidermal development of wheat leaves have been reported by Awasthi and Shukla (1988).

As far as agricultural productivity improvements are concerned, the commendable advances which started in sixties must continue. These include increase in fertilizer production and use of new dwarf varieties of seeds, increased irrigation and cropping intensity, and specific inputs for dry land and marginal land farming. The quality of agricultural research,

and the transfer of information from laboratory to land have made phenomenal progress and must be further intensified. This requires response of farmers in adopting new technologies and methods. Thus, frontier areas of science are likely to supplement the stupendous national effort being made to increase agricultural output.

Biotechnological research has been in progress in a few laboratories in the country and more is planned including a very ambitious national programme. But in order to be in forefront of the developments that are taking place, greater coordination is necessary. It is recognised that an unassailable and strong agricultural economy is going to be a major factor in ushering in a more prosperous and confident future. Agriculture can not thrive in isolation in this scheme of things. As in many other areas, development will have to match local conditions.

In India changes began after independence, first through import substitution, and then through the "Green Revolution", education in agriculture, extension programmes, increasing use of dwarf hybrids, fertilizers, pesticides and herbicides, and progressive coverage through irrigation all helped in these efforts. In spite of all these agricultural productivity is still predominantly monsoon dependent.

The production of wheat, paddy and sugar has increased spectacularly through the application of modern agricultural method of multipronged improvements in crop care, storage and distribution of produce. However, the crop of maize could not attract such a vast degree of research owing to its lesser commercial value in India. But there are signs in the value of incremental output compared to input costs.

As a result of the already high level of agricultural productivity and surpluses in the western world, biological and genetic research will continue to be predominantly devoted to human health in preference to agriculture, furthermore scientific applications in agriculture are not readily transferable unless there are suitable receiving agencies. Differences in agro-climatic condition and plant types are also important factors.

Biotechnology is sometimes erroneously thought to refer to genetic engineering. While genetic engineering is the specific technique of transferring gene expression through laboratory intervention, biotechnology involves converting discoveries in new biology into industrial and agricultural applications. These include a whole series of disciplines such as nitrogen fixation, fermentation, plant hydrocarbon, antibiotics, vaccines, microbial insecticides, biomas production and multiple

crop production of better quality. Not only this but another new aspect of plant physiology is biotechnological application of growth promoters or regulators assuming considerable importance in U.S.A., Europe and even in South-East Asia, Most of these mimic the natural substances present in plants such as hormones and auxins.

Literature excels in excellent experimental work of eminent scientists dealing with aquatic plants, still there are wide gaps in our knowledge to fully exploit *S. polyrhiza* attributes likely to offer solution on an array of botanical quizzes. This interesting perspective has met only a causal arbitrary and partial treatment during the works of various investigators in the past. Nothing is known towards application of *S. polyrhiza* extracts with special reference to growth, development and yield of maize plants, and how its metabolism and morpho-anatomical attributes are altered for better adaptability of the crop to multiply growth and better enriched yield. Interestingly, enough existence of such substances in certain plant extracts like *S. polyrhiza* eliminates problems of manufacture, side effects on crop productivity and ensures overall safety and public health. Exploration and enquiry over such latest biotechnology, the cost of which for adoption by growers of commercial crop of maize would be insignificant compared to the benefits to be derived appears to be of great importance.

But as Hillman (1961) rightly pointed out that "While adequate coverage of all work with a particular group of plants must perforce touch most fields of botanical research, it is impossible to consider each of the problems in its general context, to do so would be to write an encyclopedia". This brief synoptical background presented here sufficiently pinpoints existing state of knowledge and suggest areas of research on *S. polyrhiza* forming theme of present investigation dealing with utilization of *S. polyrhiza* extracts with special reference to growth, yield, respiration, catalase activity and certain plant constituents like nitrogen, protein, sugars, starch and chlorophyll, and morpho-anatomical response of maize plants.

Conclusively, biological research and commercial application is a major strength of this project of both applied and academic significance, and is likely to usher in new land marks on productivity front of this major cereal crop of maize.

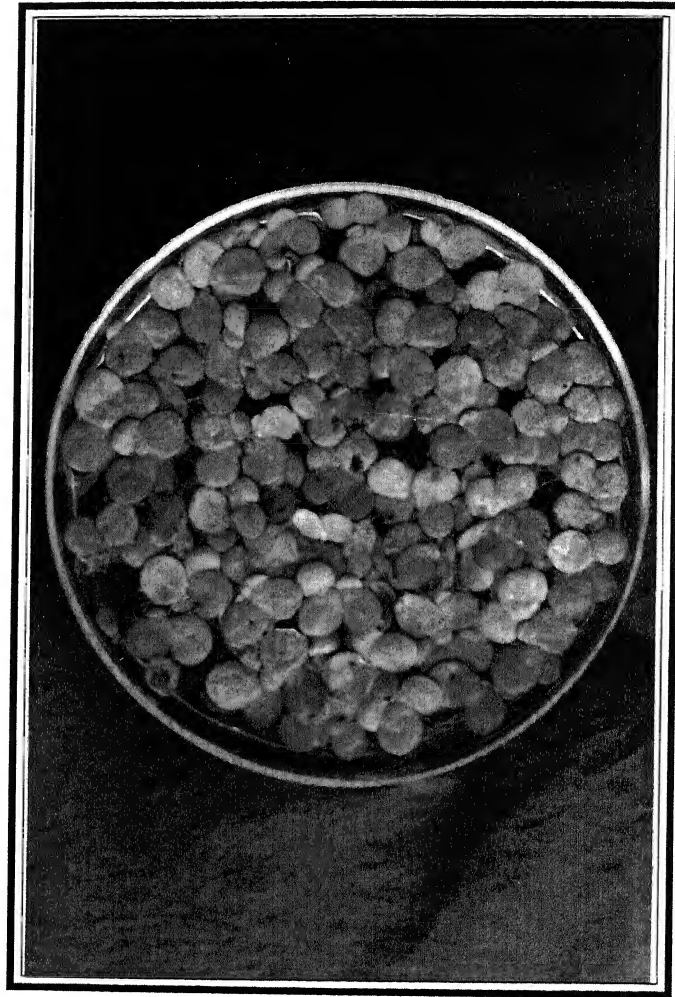
MATERIAL AND METHOD

MATERIAL AND METHOD

Out of a vast array of hydrophytic plants *S. polyrhiza* was particularly chosen as experimental material to study prospects of its utilization in agriculture of maize, in view of its common small sized hydrophytic plant body and ease of *in vitro* culture.

The experimental material was collected from nature in healthy condition and plants of equal size and shape were carefully selected. Selected plants were vigourously washed in tap water to remove adhering debris and algae. Finally, the material was washed with distilled water and cultured in thoroughly acid and distilled water washed rectangular glass containers 2.5' long, 1' broad and 1.5' deep containing culture medium. Medium with organic nutrients like sugars, coconut milk and soil extracts were found unsuitable as they either supplemented to the growth of contaminants or bore unknown composition. Culture medium as modified and suggested by Pandey (1979) with following composition was selected for bulk use for maintenance of stock cultures. The medium was changed fortnightly to avoid exhaustion of nutrients in the medium.

PHOTO - 3: SURFACE VIEW OF PETRI-DISH SHOWING *IN VITRO* GROWTH OF *Spirodella polyrhiza* FRONDS.

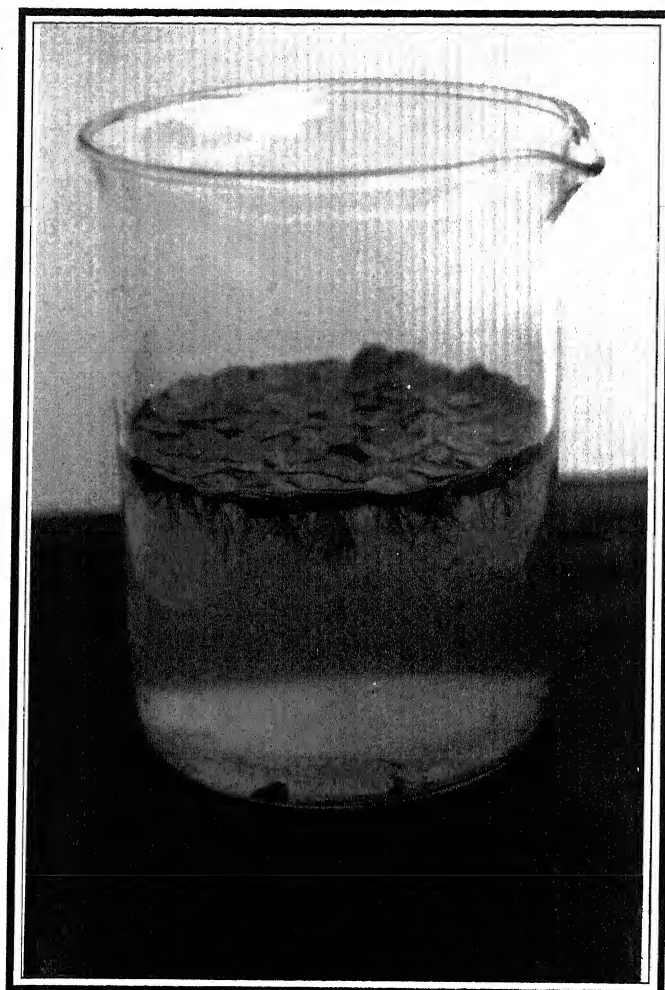


With a view to avoid variations caused due to development of fronds starting well before they become visible in culture, specially, in short term growth and metabolic studies. Fronds acclimatised for a period of about four weeks were used in a given experiments or series from the same stock and conditions were kept as close as possible to the experiments. Selection and propagation of fronds was based on the fact that despite physiological differences between early and late daughter fronds, the characteristics of a clone can not be altered. The concept of selection of fronds for use as inoculum has been purely based on equity in size and shape and not the generation time as it has been considered more apparent than real and completely misleading.

Studies on utilization of *S. polyrhiza* in agriculture were made with special reference to their use for obtaining extracts containing growth substances. Maize varieties Azad Uttam and R-49 were selected to study the effect. Genetically tested seeds were obtained from C.S. Azad University of Agriculture and Technology, Kanpur. Seeds of approximately same size and weight were selected for experiment.

S. polyrhiza was chosen as experimental material because of its quantitative abundance and growth in the district Banda. Experimental material grown in stock cultures as described

**PHOTO - 4 : LATERAL VIEW OF BEAKER SHOWING *IN VITRO*
GROWTH OF *Spirodella polyrhiza* FRONDS.**



earlier was used for preparation of *S. polyrhiza* extracts.

The extractions of *S. polyrhiza* were made in water or ether. As ether is injurious to plant growth it was allowed to evaporate and growth promoting substances were suspended in water. Five millilitre of *S. polyrhiza* by volume was taken and ground in a clean porcelain mortar with water or ether. In case of water extract sufficient water was added to make it 100 ml to have a five percent extract. In case of ether extract ether was first allowed to evaporate and the suspension was then made to 100 ml in distilled water. Two, 1 and 0.5 percent extracts were made by further dilutions with distilled water. Fifty seeds were soaked in sterilized petridishes in different concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts of *S. polyrhiza* and distilled water (control) for 6 and 12 hrs. Desired concentrations used in experiments to study various parameters are specified separately below.

Immediately after the soaking period seedlings were grown in test tubes filled with distilled water on equal sized filter papers following Garrard's (1954) technique. The experiments were carried out at a temperature of 30-35°C, the normal temperature range of crop in nature. Observations were made after every forty eight hours with in experimental duration of the crop on length of main root, length of lateral roots, number

of lateral roots, length of shoot and number of leaves.

The effect of treatments was studied under field conditions in the garden beds laid for specific purposes with dimensions of 8 feet in breadth and 10 feet in length. Each bed was sown with 3 rows containing 9 seeds spaced 25 cm in rows 60 cm. apart. Thus, total number of plants grown in each bed were 27 out of which 25 were selected for observations. Two beds of each treatment and normal untreated control were laid to raise 50 replicates. Seeds of maize varieties Azad Uttam and R-49 were soaked for 6 and 12 hrs in various concentrations of extracts. In case of maize variety Azad Uttam 5 percent water and ether extracts and in R-49, 1 percent water and ether extracts were chosen for observing effects under normal field conditions as out of various concentrations used to study seedling growth, these concentration were found to be beneficial to the maximum extent and therefore, it was thought to study sustained effect of such treatments on subsequent mature crop growth, development and yield. Garden beds were prepared after ploughing the area and mixing adequate amount of manure in ratio of 3 parts of soil and 1 part cowdung manure in upper crust of soil. Seeds soaked in distilled water were similarly sown and served as control. Observations were recorded on vegetative growth with reference to height of plant, number of leaves per plant, and average

length and breadth of leaves at an interval of 15 days (15, 30 and 45 days) during 45 days duration of the crop. Observation on yield were made over number of fruits per plant, number of floral branches per male inflorescence, fruit maturation period and trend of fruit setting. The matured crop was then harvested after 75 days and fresh weight of vegetative foliage, fresh weight of male inflorescence, fresh weight of fruits per plant, fresh weight of single fruit with leafy coverings, fresh weight of single fruit without leafy coverings and fresh weight of leafy coverings were recorded. Observations on dry weight of vegetative foliage, dry weight of male inflorescence per plant, dry weight of fruits per plant and dry weight of 1000 seeds were recorded. Dry weights were recorded after drying these parts under sun for a period of 7 days and then placing them in an incubator maintained at 35° C to be weighed till their dry weights were constant. Increase in yield of maize varieties Azad Uttam and R-49 per acre were then calculated on the basis of yield in experimental plots. Observations were made on 50 replicates and average results were taken into consideration.

Assay of nitrogen, protein, phosphorus and pottash contents in seeds collected from plants after 75 days from treated plants with *S. polyrhiza* extracts in concentrations (5 percent in case of variety Azad Uttam and 1 percent in variety

Results have been statistically analysed following of variance method and effect of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Size of Metaxylem :

The effect of water and ether extracts have been recorded in Table-24 and Photo-12. Different concentrations (0.5, 2 and 5 percent) of water and ether extract impart increase in size of metaxylem. However, effect of ether extract is more pronounced. Maximum size of metaxylem has been observed in 5 percent treatment with ether extract.

The data has been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Number of Metaxylem :

A perusal of Table-24 and Photo-23 show that there is no effect of various concentration (0.5, 1, 2 and 5 percent) of water and ether extracts on number of metaxylem.

Statistical analysis of data shows that effect of treatments is insignificant at 5 percent error probability.

treatments pieces of roots were carefully selected from five cm. below root-shoot transition zones. Material of stem was cut carefully from both treatments (with 5 percent water and ether extracts in variety Azad Uttam and 1 percent water and ether extracts in variety R-49) and control. Pre-soaking seed treatments for 6 and 12 hrs were applied. Treated and control plants were grown in garden beds as described earlier. Stem pieces of 2 cm. were collected from 5 cm below the top of the plant. Such materials of each treatment were preserved in formalin aceto-alcohol containing a mixture of 70 percent ethyl alcohol 90 ml, glacial acetic acid 5 ml and formalin 5 ml. The material was then dehydrated and was microtomed using senior rotary microtome. Slides of materials prepared were stained in safranin and fast green following Johansen's technique (1940). Observations on diameter of root, diameter of stele, diameter of vascular bundles, number of vascular bundles, size of metaxylem and number of metaxylem in root sections, and diameter of stem, number of vascular bundles, diameter of xylem and phloem and diameter of tracheids in stem sections in each treatment were recorded. Results expressed are average of twenty five replicates.

Effect of 6 and 12 hrs pre-soaking seed treatments with 0.5, 1, 2 and 5 percent water and ether extracts of *S. polyrhiza* on stomatal and epidermal development of maize

seedlings variety Azad Uttam and R-49 were studied following technique suggested by Shukla (1969). Treated maize seedlings were allowed to grow for 192 hrs. Second leaf of seedlings from base in different treatment was collected and preserved in alcohol (Lloyd, 1908). The stomatal and epidermal studies were made from peelings of leaves. Both upper and lower epidermal peelings were taken out and stained preparations were observed microscopically. Observations on number of stomata, perimeter of single stomatal opening, number of epidermal cells, length of epidermal cells and breadth of epidermal cells were made in an area of 1984 sqμ of leaf peelings. Average of 25 replicates were taken into consideration.

The data was analysed statistically following analysis of variance method at 5 percent error probability for testing the significance of the effect of treatments. Results of statistical analysis are entered in respective observation tables.

CHAPTER 1

STUDIES ON INFLUENCE OF
Spirodella polyrhiza EXTRACTS
ON JUVENILE SEEDLING
GROWTH AND DEVELOPMENT
OF MAIZE.

STUDIES ON INFLUENCE OF *Spirodella* *polyrhiza* EXTRACTS ON JUVENILE SEEDLING GROWTH AND DEVELOPMENT OF MAIZE

Influence of water and ether extract suspended in water of *S. polyrhiza* has been studied on growth and development of maize seedlings employing Garrard's (1954) technique. The effect has been studied on two maize varieties viz. Azad Uttam and R-49. Pre-soaking seed treatments for 6 and 12 hrs was given with *S. polyrhiza* extracts to study the effect on germination, growth and development of the two varieties of maize. The observations are recorded below.

EFFECT ON MAIZE VARIETY AZAD UTTAM :

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT WITH WATER EXTRACT

Effect on Length of Main Root :

Observations on effect of pre-soaking seed treatment on length of main root have been recorded in Table-1 and Graph-1A, 1B. A perusal of data shows that different concentrations of water extract (0.5, 1, 2 and 5 percent) exercise a sustained beneficial effect. Treatment with 5 percent marks maximum

TABLE - 1 : EFFECT OF 6 HRS PRE-SOAKING SEED TREATMENT WITH WATER EXTRACT OF *Spirodella polyrhiza* ON GROWTH AND DEVELOPMENT OF MAIZE (AZAD UTTAM) SEEDLINGS (AVERAGE OF 50 REPLICATES)

WATER EXTRACT

AGE OF SEED-LINGS IN HRS	LENGTH OF MAIN ROOT IN CM					AVERAGE LENGTH OF LATERAL ROOTS IN CM					NUMBER OF LATERAL ROOTS					LENGTH OF SHOOT IN CM					NUMBER OF LEAVES				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
48	3.0	3.1	3.4	3.5	3.8	0.7	0.8	1.0	1.8	1.9	1.7	2.0	3.1	3.2	3.4	3.1	4.1	4.5	4.6	4.8	A	A	A	A	A
96	9.3	9.4	9.5	9.6	9.9	6.5	6.6	6.8	6.8	6.9	3.1	4.1	4.2	4.3	4.4	4.6	4.6	5.3	5.4	5.5	1.1	1.3	1.4	1.4	1.5
144	9.8	10.0	10.4	10.6	10.8	6.6	6.7	6.9	7.0	7.1	3.2	4.2	4.3	4.4	4.5	4.7	4.7	5.4	5.5	5.6	2.0	2.2	2.5	2.6	2.8
192	9.8	9.9	10.6	10.7	10.9	6.9	7.1	7.1	7.2	7.3	3.4	4.3	4.5	4.5	4.6	4.8	4.9	5.5	5.6	5.8	2.1	2.3	2.6	2.8	3.0

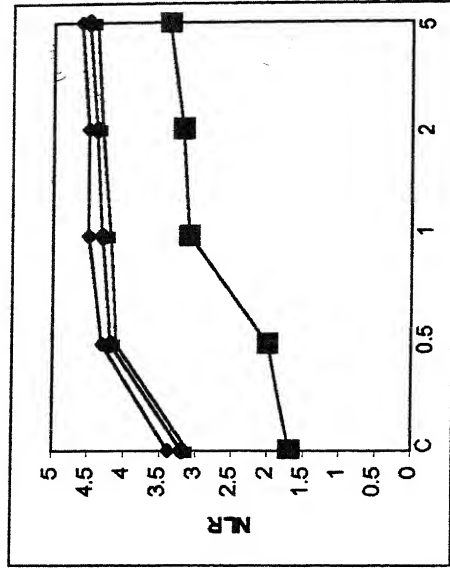
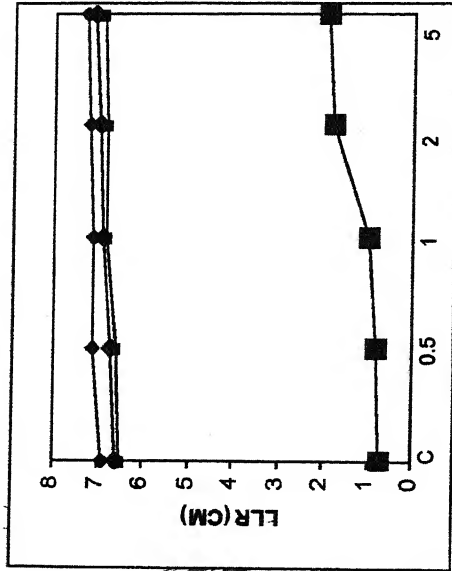
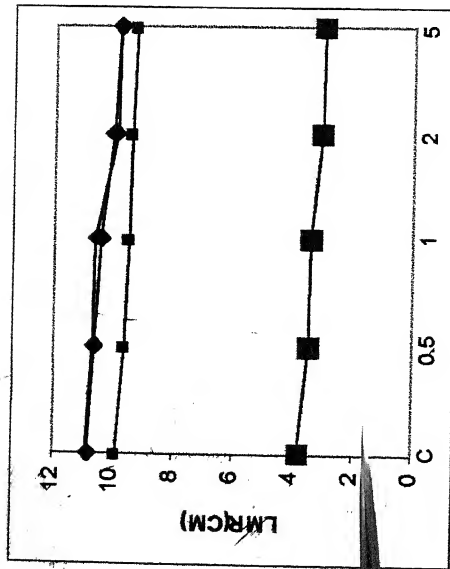
Difference calculated at 192 hrs	C.D. = 0.19 DIFF. 5% - C = 1.10	C.D. = 0.30 DIFF. 5% - C = 0.40	C.D. = 0.31 DIFF. 5%-C = 1.20	C.D. = 0.26 DIFF. 5%-C = 1.00	C.D. = 0.23 DIFF. 5%-C = 0.90
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ABBREVIATIONS USED : C = Control, C.D. = Critical Difference, A = Absent

GRAPH NO.-1: EFFECT OF 6 HRS. WATER EXTRACT ON SEED-LING GROWTH OF MAIZE (AZAD UTTAM).

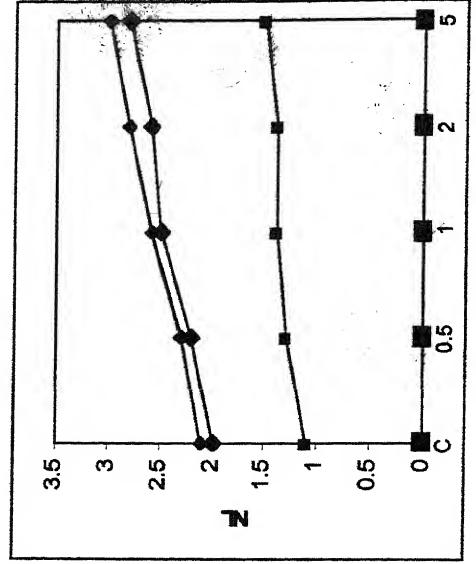
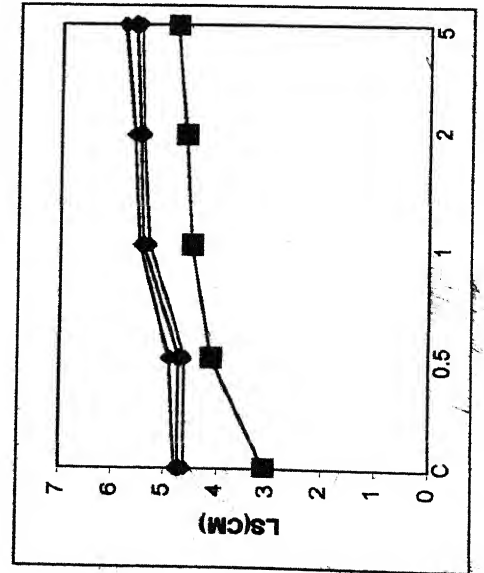
LMR : Length of main root
LLR : Length of lateral roots
NLR : Number of lateral roots
LS : Length of shoot
NL : Number of leaves

GRAPH-1A EFFECT OF 6 HRS WATER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZAD UTTAM).



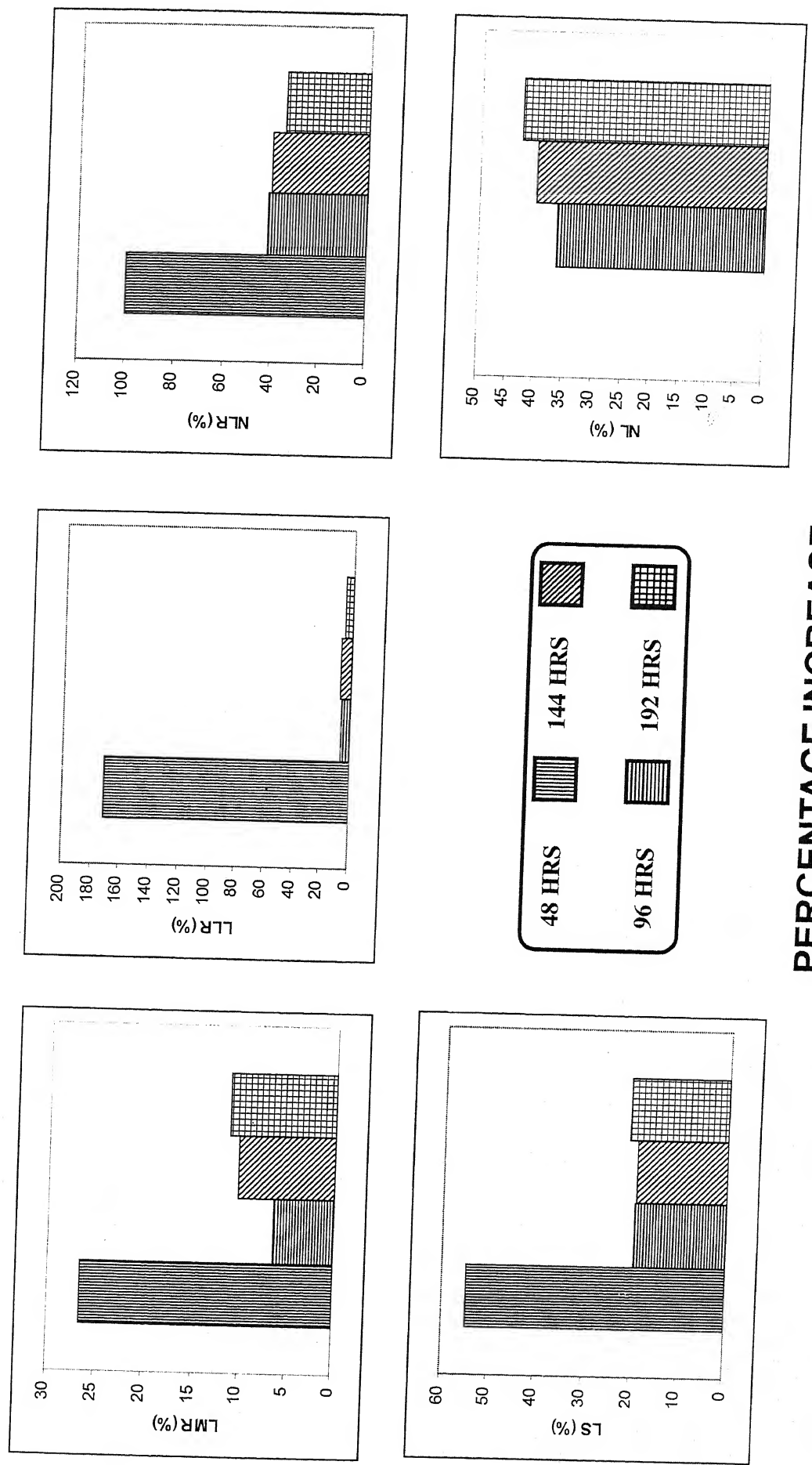
—■— 48 HRS —■— 98 HRS —◆— 144 HRS —◆— 192 HRS

C = CONTROL



CONCENTRATIONS
IN
PERCENT

GRAPH-1B EFFECT OF 6 HRS WATER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZAD UTTAM).



PERCENTAGE INCREASE

promotion and the effect gradually decreases with decrease in concentration of extracts.

The results have been statistically analysed following analysis of variance method and the effect with 5 percent water extract has been found to be significant.

Effect on Length of Lateral Roots :

Results given in Table-1 and Graph-1A, 1B show that there is an over all increase in length of lateral roots with different concentrations (0.5, 1, 2 and 5 percent) of water extract and the beneficial influence is maintained throughout the duration of observation. Gradual increase in concentration of water extract applied stimulates length of lateral roots to larger extent and 5 percent is maximum in effectiveness.

Statistical analysis of data shows that observed increase with 5 percent water extract is significant.

Effect on Number of Lateral Roots :

Results on response of number of lateral roots following pre-soaking seed treatment entered in Table-1 and Graph-1A, 1B show that treatment with different concentrations (0.5, 1, 2 and 5 percent) exercise marked increase in number of laterals developed in seedlings treated with 5 percent water extract. The beneficial effect of treatment was observed from

the beginning of observations and was maintained in subsequent observations upto 192 hrs.

Statistical analysis of results shows that observed increase in number of laterals with 5 percent treatment is significant.

Effect on Length of Shoot :

A perusal of data given in Table-1 and Graph-1A, 1B shows that treatment with various concentrations (0.5, 1, 2 and 5 percent) of water extract increases length of shoot. Gradual increase in concentration of water extract applied brings about stimulated growth of shoot throughout the duration of experiment. However, treatment with 5 percent is maximum in effectiveness.

Statistical analysis of results was made following analysis of variance method. Observed increase in length of shoot with 5 percent water extract has been found to be significant at 5 percent error probability.

Effect on Number of Leaves :

Observations given in Table-1 and Graph-1A, 1B show that emergence of leaves started only after 96 hrs after pre-soaking seed treatment. In the beginning at 96 hrs effect of treatment with various concentrations of water extract was identical but subsequently, gradual increase in concentration

of water extract increased number of leaves. However, treatment with 5 percent water extract exercised maximum increase in number of leaves.

Observed increase in number of leaves with 5 percent treatment has been found to be statistically significant at 5 percent error probability.

INFLUENCE OF 6HRS PRE-SOAKING SEED TREATMENT WITH ETHER EXTRACT :

Effect on Length of Main Root :

Observations on effect of pre-soaking seed treatment on length of main root have been recorded in Table-2 and Graph-2A, 2B. A perusal of data shows that different concentrations (0.5, 1, 2 and 5 percent) of ether extract exercise a sustained beneficial effect. Treatment with 5 percent marks maximum promotion and the effect gradually decreases with decrease in concentration of extracts.

The results have been statistically analysed following analysis of variance method and the effect with 5 percent ether extract has been found to be significant.

Effect on Length of Lateral Roots :

Results given in Table-2 and Graph-2A, 2B show that there is an overall increase in length of lateral roots with

***GRAPH NO.-2: EFFECT OF 6 HRS. ETHER EXTRACT ON SEED-
LING GROWTH OF MAIZE (AZAD UTTAM).***

LMR : Length of main root

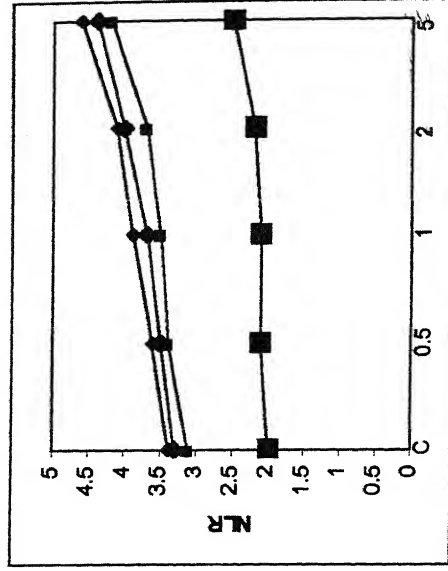
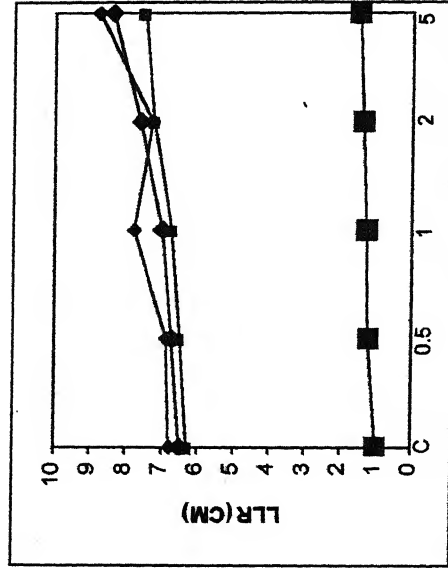
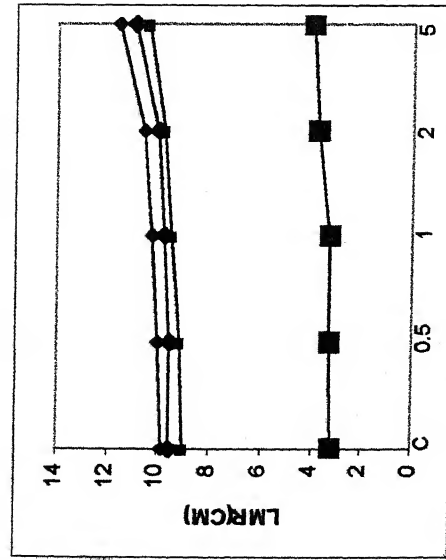
LLR : Length of lateral roots

NLR : Number of lateral roots

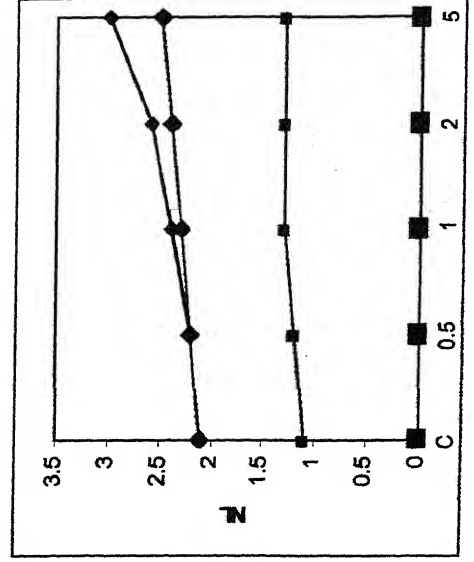
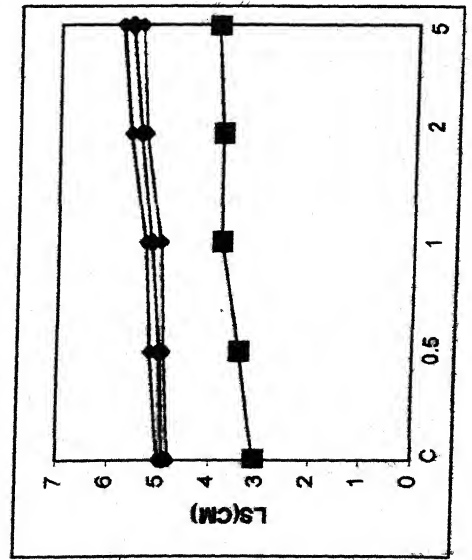
LS : Length of shoot

NL : Number of leaves

GRAPH-2A EFFECT OF 6 HRS ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZAD UTTAM).

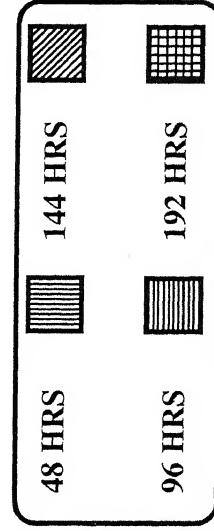
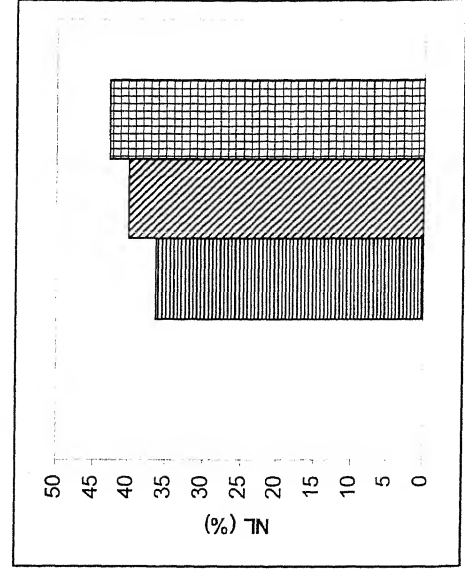
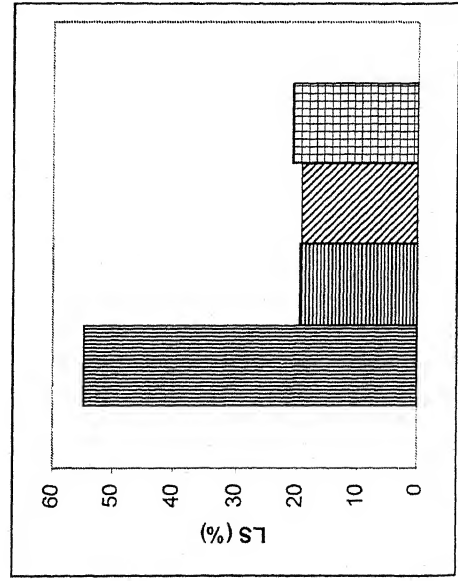
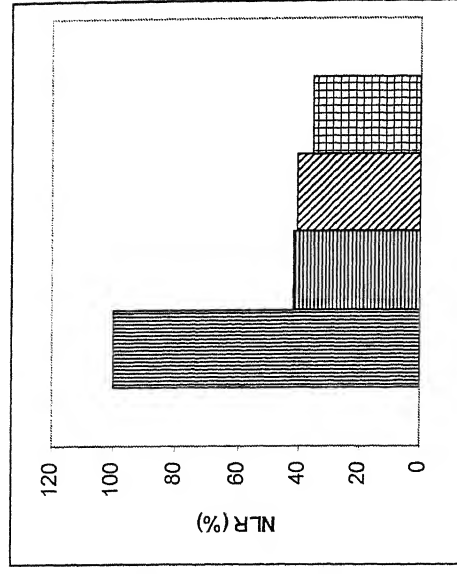
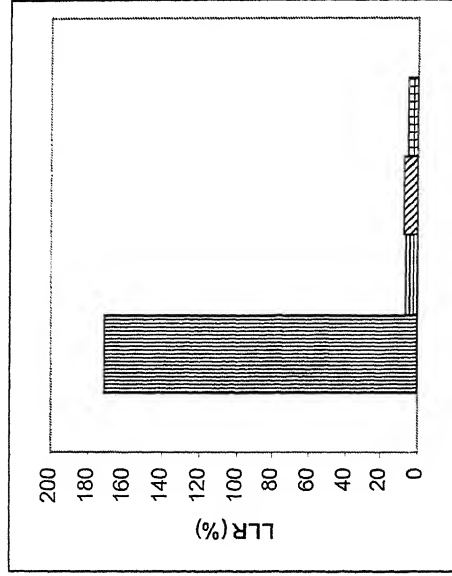
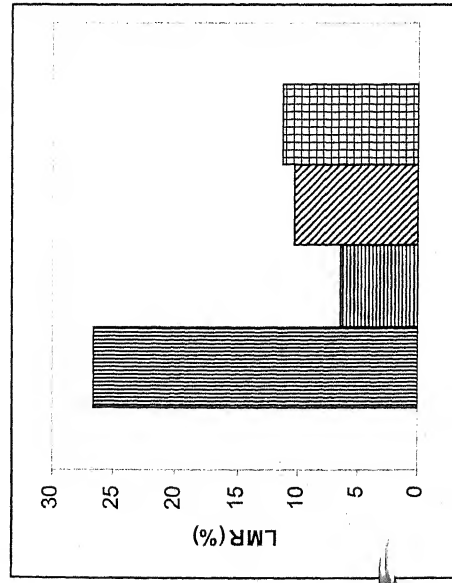


—■— 48 HRS —◆— 98 HRS —▲— 144 HRS —●— 192 HRS
 C = CONTROL



CONCENTRATIONS
 IN
 PERCENT

GRAPH-2B EFFECT OF 6 HRS ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZADUTTAM).



PERCENTAGE INCREASE

different concentrations (0.5, 1, 2 and 5 percent) of ether extract and the beneficial influence is maintained throughout the duration of observation. Gradual increase in concentration of extract applied stimulates length of lateral roots to larger extent and 5 percent is maximum in effectiveness.

Statistical analysis of data shows that observed increase with 5 percent ether extract is significant.

Effect on Number of Lateral Roots :

Results on response of number of lateral roots following pre-soaking seed treatment entered in Table-2 and Graph-2A, 2B show that treatment with different concentrations (0.5, 1, 2 and 5 percent) exercise marked increase in number of laterals developed in seedlings treated with 5 percent ether extracts. The beneficial effect of treatment was observed from the beginning of observations and was maintained in subsequent observations up to 192 hrs.

Statistical analysis of result shows that observed increase in number of laterals with 5 percent treatment is significant.

Effect on Length of Shoot :

A perusal of data given in Table-2 and Graph-2A, 2B show that treatment with various concentrations (0.5, 1, 2 and 5 percent) of ether extract increases length of shoot. Gradual

increase in concentration of ether extract applied brings about stimulated growth of shoot throughout the duration of experiment. However, treatment with 5 percent is maximum in effectiveness.

Statistical analysis of results was made following analysis of variance method. Observed increase in length of shoot with 5 percent ether extract has been found to be significant at 5 percent error probability.

Effect on Number of Leaves :

Observations given in Table-2 and Graph-2A, 2B show that emergence of leaves started only after 96 hrs after pre-soaking seed treatment. In the beginning at 96 hrs effect of treatment with various concentrations of ether extract was identical but subsequently, gradual increase in concentration of ether extract increased number of leaves. However, treatment with 5 percent extract exercised maximum increase in number of leaves.

Observed increase in number of leaves with 5 percent treatment has been found to be statistically significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENTS WITH WATER EXTRACT :

Effect on Length of Main Root :

A perusal of data entered in Table-3 and Graph-3A, 3B indicates that 0.5, 1, 2 and 5 percent water extracts exercise a beneficial effect on length of main root while 0.5 percent is minimum in effectiveness, 5 percent promotes length of main root to the maximum extent. An over all stimulatory effect is apparent at different observation periods.

The results were statistically analysed following analysis of variance method and results suggest that treatment with 5 percent water extract exercises statistically significant promotion in length of main root.

Effect on Length of Lateral Roots :

Results given in Table-3 and Graph-3A, 3B are suggestive of an all-round stimulatory effect of treatments with various concentrations (0.5, 1, 2 and 5 percent) of water extracts. Gradual increase in concentration of water extracts exercises increase in length of laterals. However, the beneficial effect of treatment could be observed throughout the duration of experiment. Treatment with 5 percent water extract promotes length of lateral roots to the maximum extent.

TABLE - 3 :

EFFECT OF 12 HRS PRE-SOAKING SEED TREATMENT WITH WATER EXTRACT OF *Spirodella polyrrhiza* ON GROWTH AND DEVELOPMENT OF MAIZE (AZAD UTTAM) SEEDLINGS (AVERAGE OF 50 REPLICATES)

WATER EXTRACT

AGE OF SEED-LINGS IN HRS	LENGTH OF MAIN ROOT IN CM					AVERAGE LENGTH OF LATERAL ROOTS IN CM					NUMBER OF LATERAL ROOTS					LENGTH OF SHOOT IN CM					NUMBER OF LEAVES				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
48	5.4	5.5	5.5	5.6	5.7	1.4	1.8	2.0	2.2	2.4	2.1	2.2	2.2	2.5	3.0	2.5	2.8	3.4	3.5	3.6	A	A	A	A	A
96	8.2	8.8	9.0	9.4	9.6	5.0	5.4	5.6	5.8	6.0	2.9	3.2	3.4	3.6	3.8	3.6	3.8	3.9	4.0	4.1	1.4	1.8	1.9	1.9	2.0
144	9.0	9.2	9.4	9.8	10.1	5.8	6.0	6.4	6.8	7.0	3.0	3.6	3.7	3.9	4.0	3.8	3.9	4.0	4.2	4.4	2.2	2.4	2.5	2.6	2.8
192	9.1	9.3	9.7	9.8	10.3	6.2	6.5	6.7	6.9	7.1	3.2	3.7	3.8	4.0	4.1	4.0	4.2	4.3	4.4	4.6	2.3	2.5	2.6	2.8	3.0
Difference calculated at 192 hrs	C.D.= 0.29					C.D. = 0.12					C.D. = 0.17					C.D. = 0.21					C.D. = 0.18				
	DIFF. 5% -C = 1.20					DIFF. 5% - C = 0.90					DIFF. 5%-C = 0.90					DIFF. 5%-C = 0.60					DIFF. 5%-C = 0.70				

ABBREVIATIONS USED : C = Control, C.D. = Critical Difference, A = Absent

***GRAPH NO.-3: EFFECT OF 12 HRS. WATER EXTRACT ON SEED-
LING GROWTH OF MAIZE (AZAD UTTAM).***

LMR : Length of main root

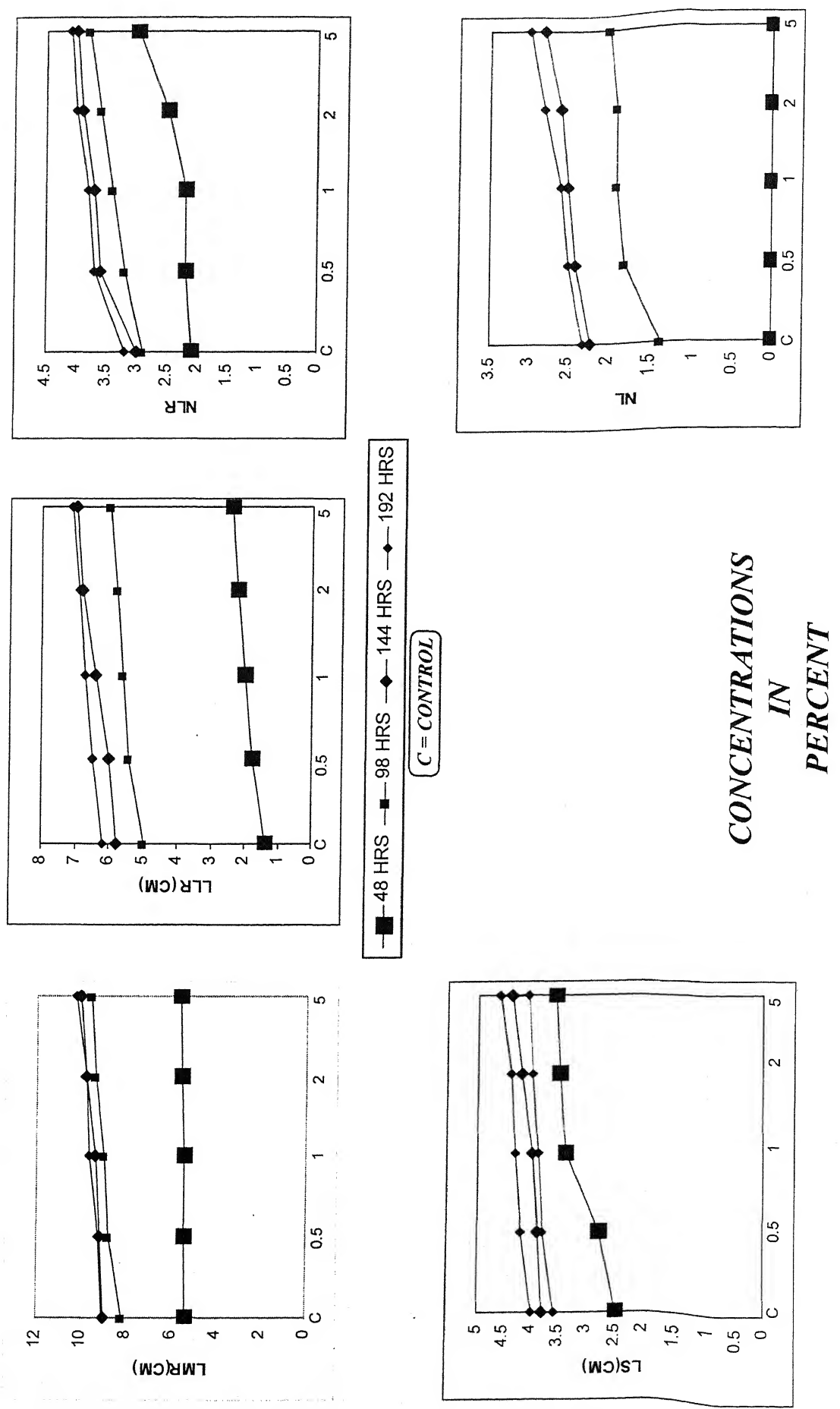
LLR : Length of lateral roots

NLR : Number of lateral roots

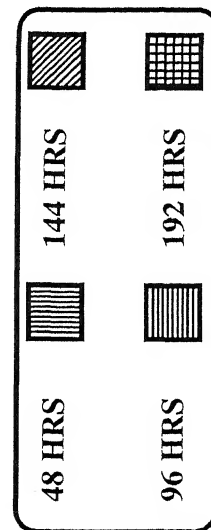
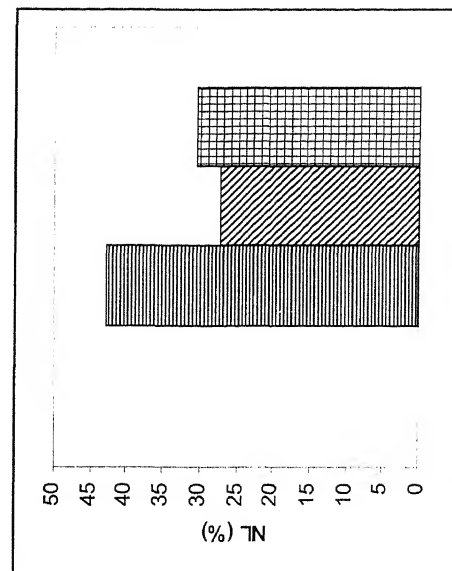
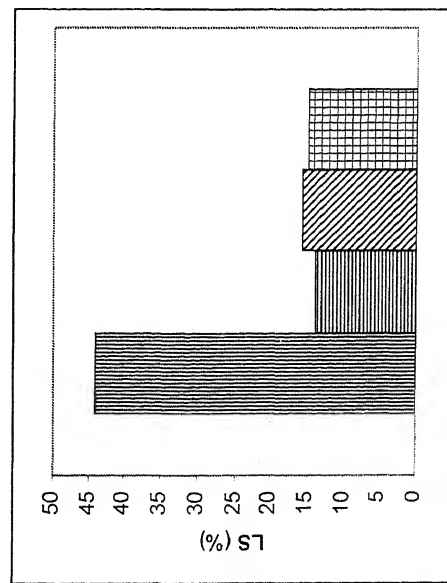
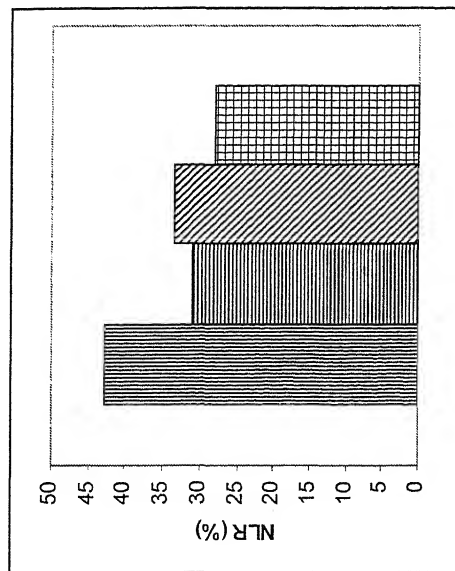
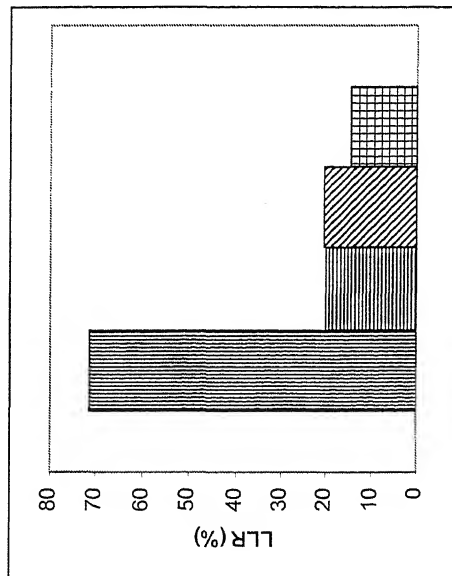
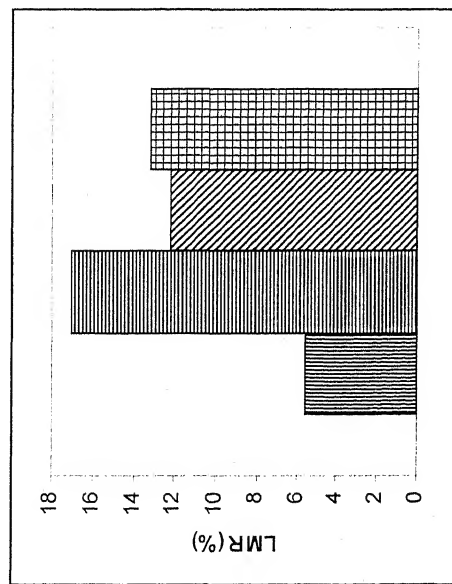
LS : Length of shoot

NL : Number of leaves

GRAPH-3A EFFECT OF 12 HRS WATER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZAD UTTAM).



GRAPH-3B EFFECT OF 12 HRS WATER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZAD UTTAM).



PERCENTAGE INCREASE

The statistical analysis of results indicates that increase observed with 5 percent water extract is significant at 5 percent error probability.

Effect on Number of Lateral Roots :

Observation on response of number of lateral roots to pre-soaking seed treatment with 0.5, 1, 2 and 5 percent water extracts are given in Table-3 and Graph-3A, 3B. The data is suggestive that all treatments have a sustained beneficial effect on number of lateral roots. However, the emergence of number of laterals increases with gradual increase in concentration of water extract. Influence of 5 percent water extract is maximum.

The data has been statistically analysed following analysis of variance method and observed increase with 5 percent water extract has been found to be statistically significant at 5 percent error probability.

Effect on Length of Shoot :

A perusal of data given in Table-3 and Graph-3A, 3B shows that treatment with various concentrations (0.5, 1, 2 and 5 percent) of water extract increase length of shoot. Gradual increases in concentration of water extract applied brings about stimulated growth of shoot throughout the

duration of experiment. However, treatment with 5 percent is maximum in effectiveness.

The statistical analysis of results was made following analysis of variance method. Observed increase in length of shoot with 5 percent water extract has been found to be significant at 5 percent error probability.

Effect on Number of Leaves :

Results on response of leaf emergence to treatment with *S. polyrhiza* water extracts have been given in Table-3 and Graph-3A, 3B. The data shows that 5 percent water extract is maximum in effectiveness. The leaf emergence initiated after 96 hrs of pre-soaking seed treatment. Subsequent observations show that gradual increase in concentration of water extract brings about a corresponding increase in number of leaves.

Results of statistical analysis show that effect of 5 percent water extract at 192 hrs is significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT WITH ETHER EXTRACT :

Effect on Length of Main Root :

A perusal of data entered in Table-4 and Graph-4A, 4B indicate that 0.5, 1, 2 and 5 percent ether extracts exercise

TABLE - 4 :

EFFECT OF 12 HRS PRE-SOAKING SEED TREATMENT WITH ETHER EXTRACT OF *Spirodella polyrhiza* ON GROWTH AND DEVELOPMENT OF MAIZE (AZAD UTTAM) SEEDLINGS (AVERAGE OF 50 REPLICATES)

ETHER EXTRACT

AGE OF SEED-LINGS IN HRS	LENGTH OF MAIN ROOT IN CM					AVERAGE LENGTH OF LATERAL ROOTS IN CM					NUMBER OF LATERAL ROOTS					LENGTH OF SHOOT IN CM					NUMBER OF LEAVES				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
48	5.0	5.3	5.4	5.5	5.6	1.2	1.9	2.0	2.1	2.3	1.8	2.0	2.2	2.3	2.6	2.0	2.8	3.0	3.1	3.2	A	A	A	A	A
96	8.2	8.8	9.0	9.1	9.3	5.0	5.2	5.5	6.0	6.2	2.8	3.0	3.4	3.5	3.7	3.2	3.4	3.5	3.6	3.8	1.2	1.8	1.9	2.1	2.2
144	8.4	9.0	9.2	9.3	9.6	5.5	5.6	5.8	6.2	6.4	2.9	3.0	3.4	3.6	3.8	3.5	3.6	3.7	4.0	4.6	2.0	2.1	2.2	2.3	2.4
192	8.9	9.0	9.3	9.4	9.6	5.8	6.0	6.3	6.6	6.8	3.0	3.2	3.4	3.6	4.0	3.6	4.0	5.8	5.9	6.0	2.1	2.2	2.4	2.6	2.8

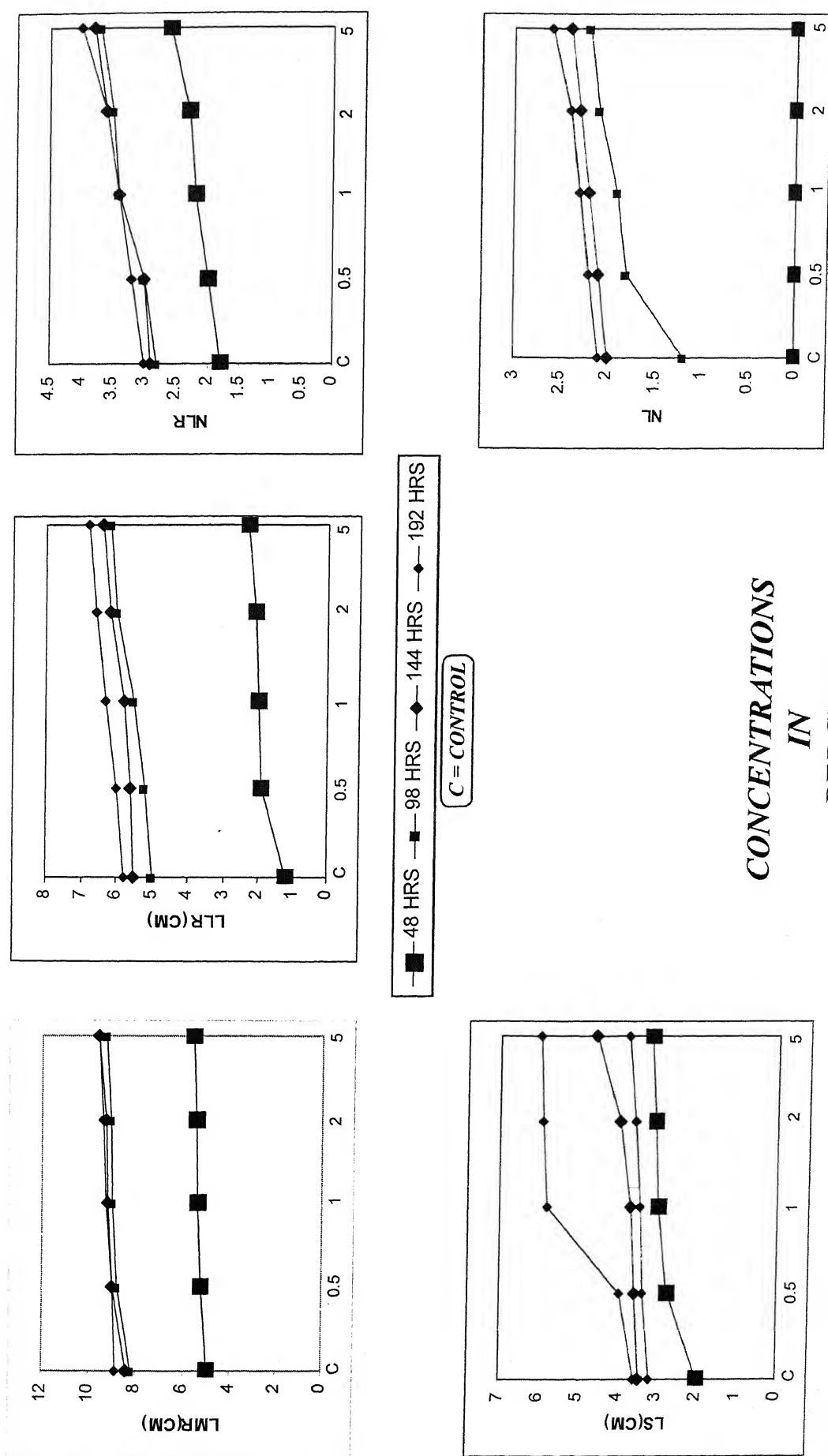
Difference calculated at 192 hrs C.D. = 0.17 DIFF. 5% - C = 0.70 C.D. = 0.30 DIFF. 5% - C = 1.00 C.D. = 0.09 DIFF. 5% - C = 1.00 C.D. = 0.65 DIFF. 5% - C = 2.40 C.D. = 0.24 DIFF. 5% - C = 0.70

ABBREVIATIONS USED : C = Control, C.D. = Critical Difference, A = Absent

***GRAPH NO.-4: EFFECT OF 12 HRS. ETHER EXTRACT ON SEED-
LING GROWTH OF MAIZE (AZAD UTTAM).***

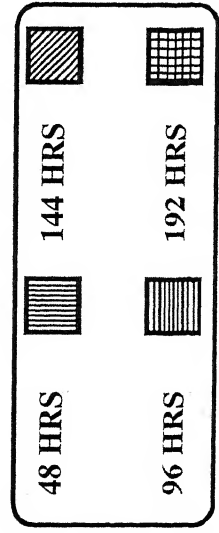
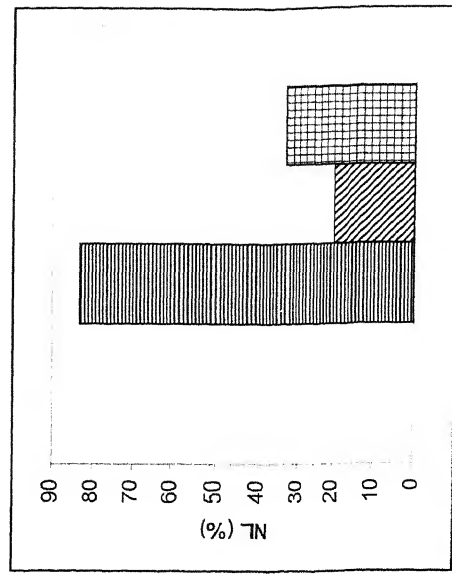
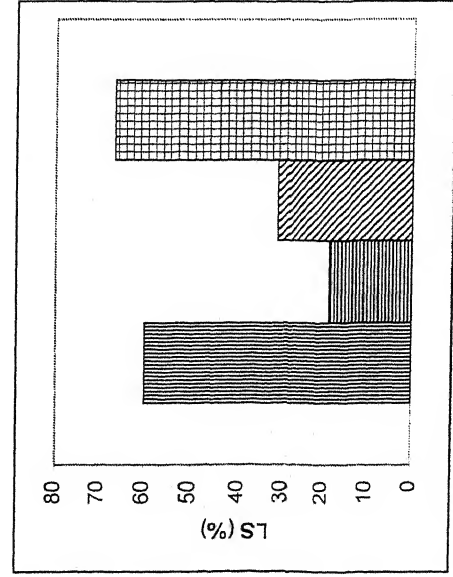
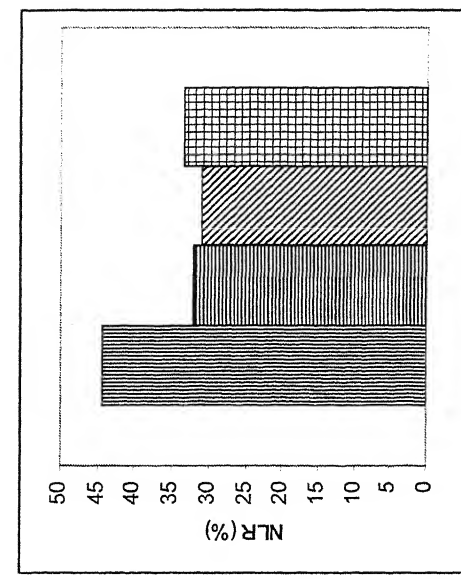
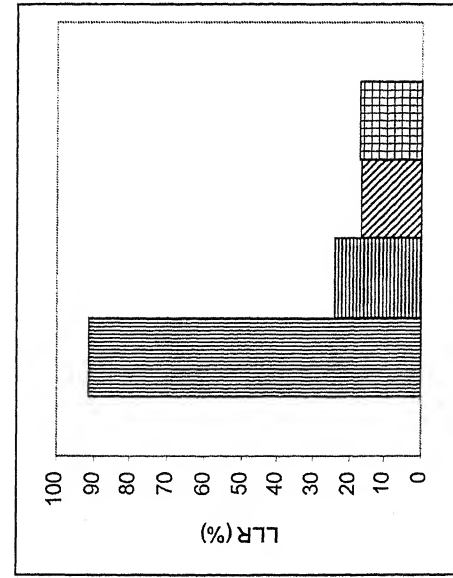
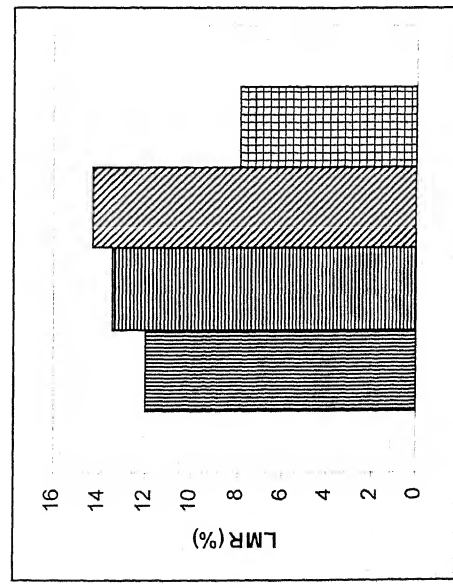
LMR : Length of main root
LLR : Length of lateral roots
NLR : Number of lateral roots
LS : Length of shoot
NL : Number of leaves

GRAPH-4A EFFECT OF 12 HRS ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZAD UTTAM).



**CONCENTRATIONS
IN
PERCENT**

GRAPH-4B EFFECT OF 12 HRS ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZAD UTTAM).



PERCENTAGE INCREASE

a beneficial effect on length of main root while 0.5 percent is minimum in effectiveness, 5 percent promotes length of main root to the maximum extent. An over all stimulatory effect is apparent at different observation periods.

The results were statistically analysed following analysis of variance method and results suggest that treatment with 5 percent ether extract exercises statistically significant promotion in length of main root.

Effect on Length of Lateral Roots :

Results given in Table-4 and Graph-4A, 4B show that there is an overall increase in length of lateral roots with different concentrations (0.5, 1, 2 and 5 percent) of ether extract and the beneficial influence is maintained throughout the duration of observation. Gradual increase in concentration of ether applied.

The statistical analysis of data shows that effect of 5 percent ether extracts is significant at 5 percent error probability.

Effect on Number of Lateral Roots :

Observation on response of number of lateral roots to pre-soaking seed treatment with 0.5, 1, 2 and 5 percent water extracts are given in Table-4 and Graph-4A, 4B. The data is

suggestive that all treatments have a sustained beneficial effect on number of lateral roots. However, the emergence of number of laterals increases with gradual increase in concentration of water extract. Influence of 5 percent water extract is maximum.

The data has been statistically analysed following analysis of variance method and observed increase with 5 percent water extract has been found to be statistically significant at 5 percent error probability.

Effect on Length of Shoot :

A perusal of data given in Table-4 and Graph-4A, 4B show that treatment with various concentrations (0.5, 1, 2 and 5 percent) of water extract increase length of shoot. Gradual increases in concentration of water extract applied brings about stimulated growth of shoot throughout the duration of experiment. However, treatment with 5 percent is maximum in effectiveness.

The statistical analysis of results was made following analysis of variance method. Observed increase in length of shoot with 5 percent water extract has been found to be significant at 5 percent error probability.

Effect on Number of Leaves :

Observation given in Table-4 and Graph-4A, 4B show that emergence of leaves started only after 96 hrs after pre-soaking seed treatment. In the beginning at 96 hrs effect of treatment with various concentrations of ether extract was identical but subsequently, gradual increase in concentration of ether extract increased number of leaves. However, treatment with 5 percent ether extract exercised maximum increase in number of leaves.

Observed increase in number of leaves with 5 percent treatment has been found to be statistically significant at 5 percent error probability.

EFFECT ON MAIZE VARIETY R-49 :

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT WITH WATER EXTRACT :

Effect on Length of Main Root :

Response of maize variety R-49 to pre-soaking seed treatment with *S. polyrhiza* water extracts have been entered in Table-5 and Graph-5A, 5B. A perusal of data is suggestive of an increase with different concentrations (0.5, 1, 2 and 5 percent) of water extract. It has been observed that treatment with 1 percent extract increases length of main root to the maximum extent. However, lowering or increase in concentration of extract exercises a gradual decline in length of main root.

Results were statistically analysed following analysis of variance method and observed increase with 1 percent extract at 192 hrs has been found to be significant.

Effect on Length of Lateral Roots :

A perusal of Table-5 and Graph-5A, 5B is indicative of a beneficial effect of *S. polyrhiza* water extracts. The stimulatory effect has been maintained throughout the duration of experiment. Maximum length of lateral roots has been obtained in treatment with 1 percent. However, increase or

TABLE - 5 : EFFECT OF 6 HRS PRE-SOAKING SEED TREATMENT WITH WATER EXTRACT OF *Spirodella polyrhiza* ON GROWTH AND DEVELOPMENT OF MAIZE (R-49) SEEDLINGS (AVERAGE OF 50 REPLICATES)

WATER EXTRACT

AGE OF SEED-LINGS IN HRS	LENGTH OF MAIN ROOT IN CM					AVERAGE LENGTH OF LATERAL ROOTS IN CM					NUMBER OF LATERAL ROOTS					LENGTH OF SHOOT IN CM					NUMBERS OF LEAVES				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
48	3.8	4.4	5.0	4.6	4.6	1.0	1.2	1.6	1.4	1.1	1.7	2.5	2.6	2.5	2.0	1.0	1.1	1.2	1.0	1.0	A	A	A	A	A
96	8.0	8.1	10.0	9.6	9.5	8.0	8.4	9.4	8.6	8.3	4.2	4.3	4.6	4.4	4.2	2.4	2.6	3.5	3.4	3.0	1.0	1.4	1.6	1.3	1.2
144	9.2	10.0	10.6	10.1	9.9	9.4	9.8	10.3	10.0	9.6	4.3	4.4	4.7	4.5	4.3	3.0	3.2	3.5	3.4	3.1	2.3	2.4	2.6	2.5	2.4
192	10.6	11.0	11.4	10.6	10.4	9.6	9.8	10.1	10.0	9.8	4.4	4.5	4.9	4.6	4.4	3.2	3.4	3.8	3.6	3.1	2.6	2.7	3.0	2.8	2.6
Difference calculated at 192 hrs	C.D. = 0.55					C.D. = 0.19					C.D. = 0.19					C.D. = 0.28					C.D. = 0.14				
	DIFF. 1% -C = 0.80					DIFF. 1% - C = 0.50					DIFF. 1%-C = 0.50					DIFF. 1%-C = 0.60					DIFF. 1%-C = 0.40				

ABBREVIATIONS USED : C = Control, C.D. = Critical Difference, A = Absent

***GRAPH NO.-5: EFFECT OF 6 HRS. WATER EXTRACT ON SEED-
LING GROWTH OF MAIZE (R-49).***

LMR : Length of main root

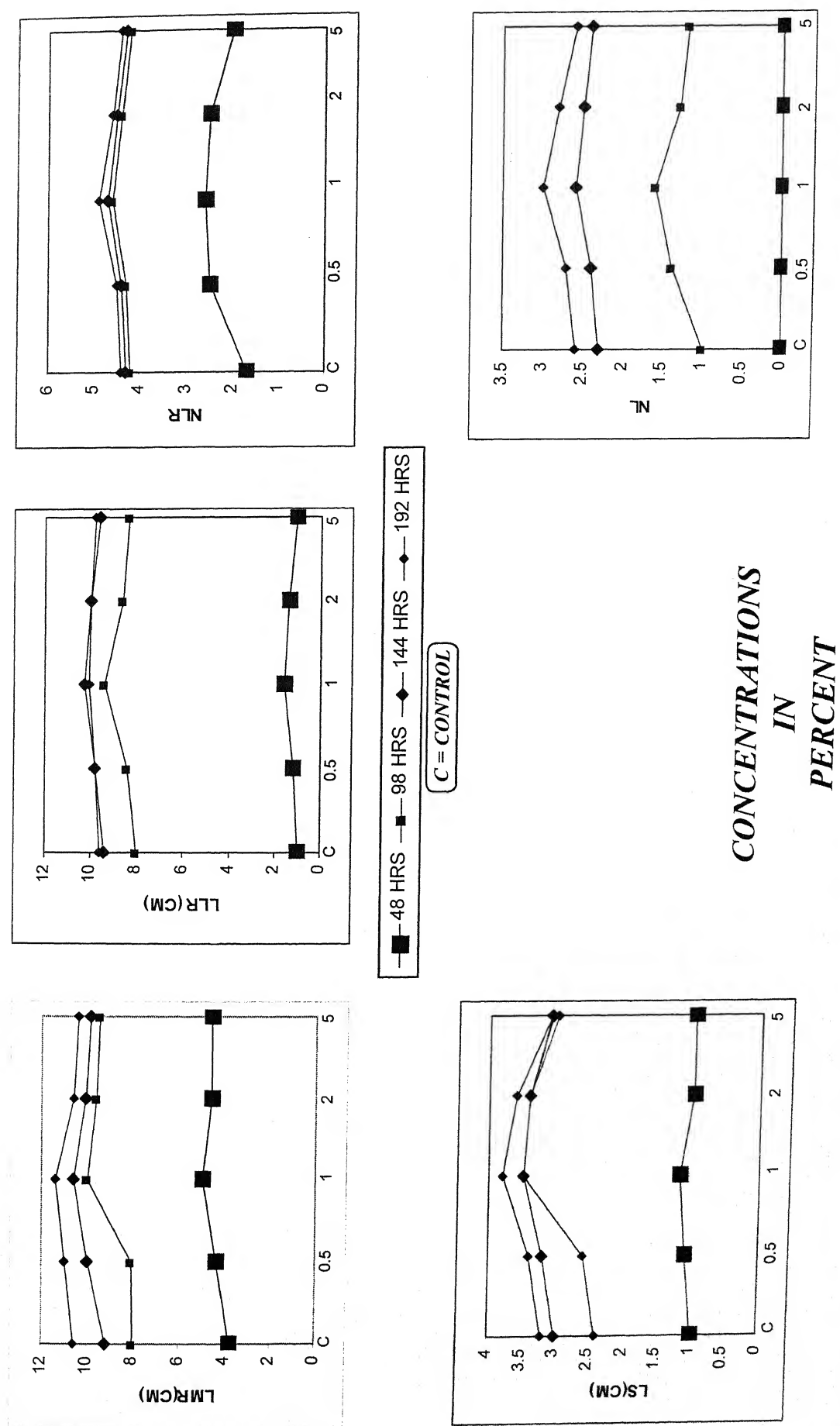
LLR : Length of lateral roots

NLR : Number of lateral roots

LS : Length of shoot

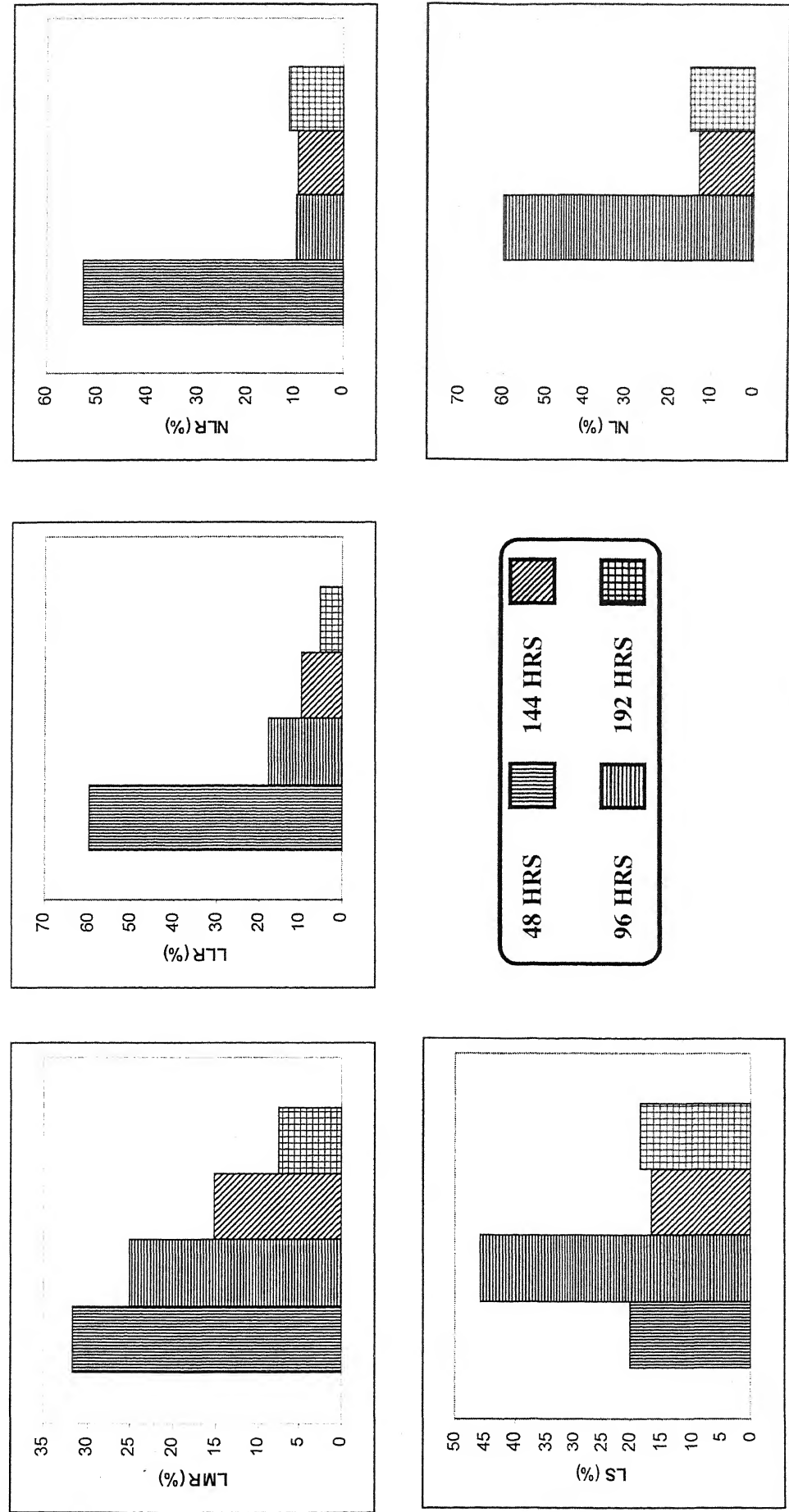
NL : Number of leaves

GRAPH-5A EFFECT OF 6 HRS WATER EXTRACT ON SEEDLING GROWTH OF MAIZE (R-49).



GRAPH-5B

EFFECT OF 6 HRS WATER EXTRACT ON SEEDLING GROWTH OF MAIZE (R-49).



PERCENTAGE INCREASE

decrease in concentration of water extract applied gradually declines the beneficial effect. The effect of various concentrations of extracts is sustained.

Statistical analysis of data shows that observed increase with 1 percent extract is significant at 5 percent error probability.

Effect on Number of Lateral Roots :

Results given in Table-5 and Graph-5A, 5B show that there is an increase in number of lateral roots from the beginning and the effect is maintained throughout the duration of experiment. While 1 percent extract exercises maximum increase in number of laterals, lowering or increase in concentration of extract correspondingly reduces the influence.

The data was statistically analysed following analysis of variance method and the effect of 1 percent extract at 192 hrs has been found to be significant at 5 percent error probability.

Effect on Length of Shoot :

Observations given in Table-5 and Graph-5A, 5B are indicative of stimulation in length of shoot. The maximum beneficial effect has been observed with 1 percent extract. Higher or lower concentrations than 1 percent reduce the

effect. Beneficial effect of extract is maintained throughout the duration of experiment.

Statistical analysis of the results obtained is suggestive of significant increase in length of shoot with 1 percent extract after 192 hrs of pre-soaking seed treatment.

Effect on Number of Leaves :

A perusal of Table-5 and Graph-5A, 5B indicate that emergence of leaves starts after 96 hrs in both normal untreated and treated seedlings. Various concentrations of extracts exercise a sustained beneficial influence on number of leaves. Maximum number of leaves emerged in treatment with 1 percent extract. A gradual decline in number of leaves was observed with correspondingly increase or decrease in concentration of extract applied.

The data has been analysed following analysis of variance method and observed increase in number of leaves with 1 percent extract has been found statistically significant at 5 percent error probability.

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT WITH ETHER EXTRACT :

Effect on Length of Main Root :

An examination of data given in Table-6 and Graph-6A, 6B show that there is an increase in length of main root with various concentrations (0.5, 1, 2 and 5 percent) of ether extract. The beneficial effect is maintained throughout the duration of experiment. Treatment with 1 percent ether extract suspended in water increases length of main root to the maximum extent. Lowering as well as increase in concentration of ether extract gradually reduces the effect.

Results obtained were statistically analysed and the data showed that observed increase with 1 percent ether extract suspended in water is significant.

Effect on Length of Lateral Roots :

Data on response of length of lateral roots to *S. polyrhiza* ether extract has been given in Table-6 and Graph-6A, 6B. Results indicate an overall better in length of laterals over control with 1 percent treatment. The beneficial effect of various concentrations of ether extract suspended in water has been maintained throughout observation period.

TABLE - 6 : EFFECT OF 6 HRS PRE-SOAKING SEED TREATMENT WITH ETHER EXTRACT OF *Spirodella polyrhiza* ON GROWTH AND DEVELOPMENT OF MAIZE (R-49) SEEDLINGS (AVERAGE OF 50 REPLICATES)

ETHER EXTRACT

AGE OF SEED-LINGS IN HRS	LENGTH OF MAIN ROOT IN CM					AVERAGE LENGTH OF LATERAL ROOTS IN CM					NUMBER OF LATERAL ROOTS					LENGTH OF SHOOT IN CM					NUMBERS OF LEAVES				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
48	3.7	4.3	4.5	4.2	3.7	0.90	1.3	1.4	1.3	1.0	1.1	2.2	2.7	2.6	2.2	1.2	1.2	1.3	1.2	0.97	A	A	A	A	A
96	8.3	8.5	9.9	7.11	7.4	8.4	8.6	8.8	7.9	6.8	3.9	3.9	4.4	4.0	3.8	2.9	3.0	3.9	3.4	3.2	0.90	1.00	1.2	1.0	1.0
144	9.9	10.8	12.2	9.8	8.4	9.4	10.2	10.6	9.9	8.1	4.3	4.4	4.8	4.6	4.1	3.0	3.2	4.0	3.6	3.3	2.0	2.8	2.5	2.1	2.1
192	10.8	11.9	12.7	9.9	9.0	9.9	10.8	10.9	10.3	8.8	4.4	4.4	4.8	4.6	4.4	3.5	3.6	4.8	3.7	3.5	2.5	2.8	2.9	2.6	2.5
Difference calculated at 192 hrs	C.D. = 0.86 DIFF. 1% -C = 1.90					C.D. = 0.56 DIFF. 1% - C = 1.00					C.D. = 0.38 DIFF. 1%-C = 0.40					C.D. = 0.32 DIFF. 1%-C = 1.30					C.D. = 0.22 DIFF. 1%-C = 0.40				

ABBREVIATIONS USED : C = Control, C.D. = Critical Difference, A = Absent

***GRAPH NO.-6: EFFECT OF 6 HRS. ETHER EXTRACT ON SEED-
LING GROWTH OF MAIZE (R-49).***

LMR : Length of main root

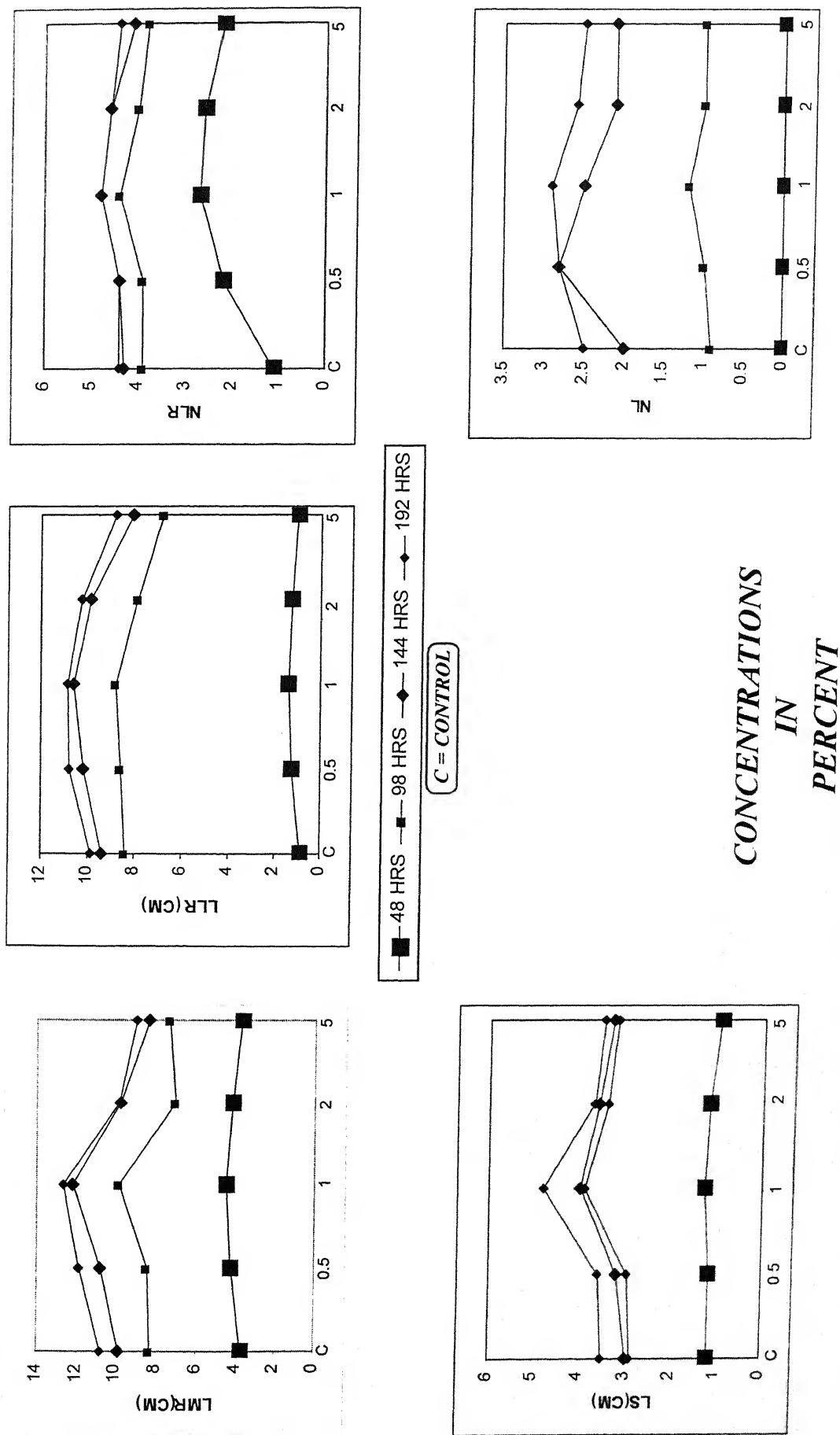
LLR : Length of lateral roots

NLR : Number of lateral roots

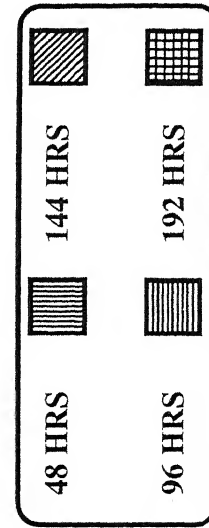
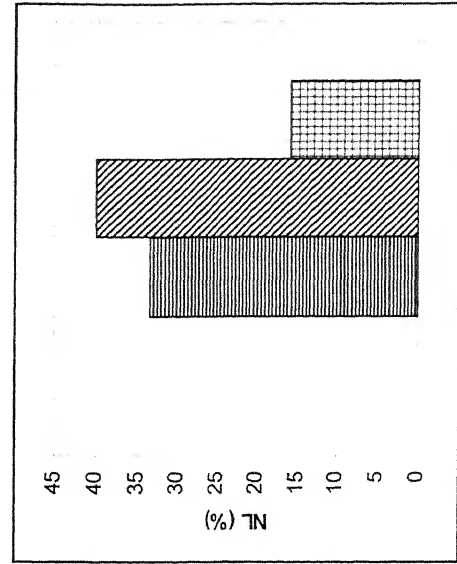
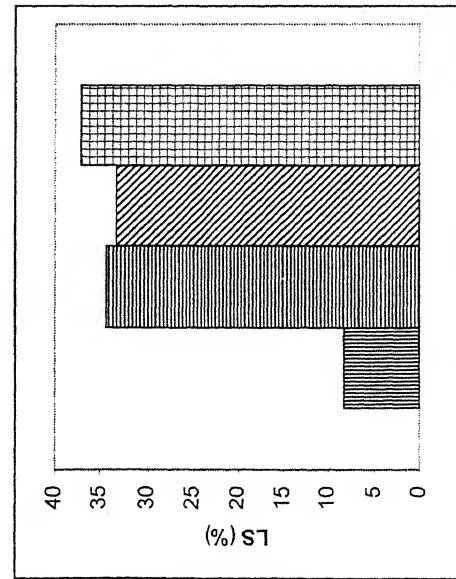
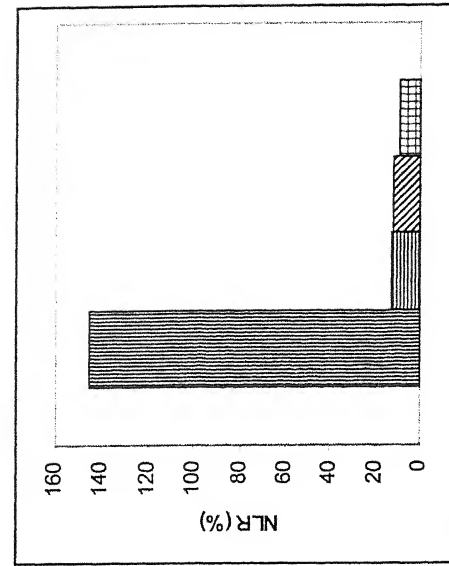
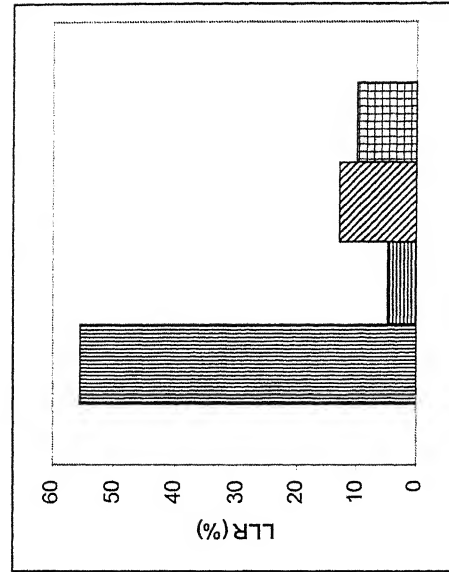
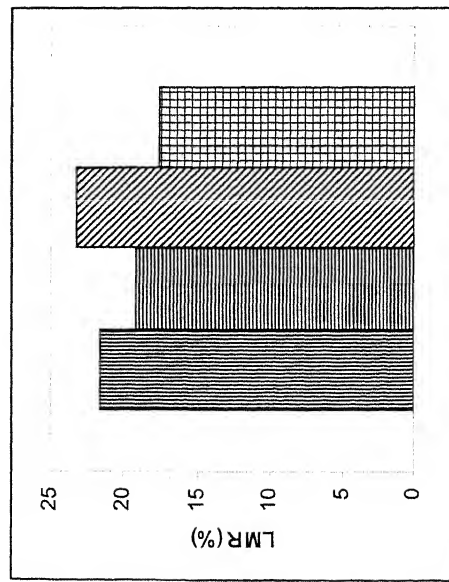
LS : Length of shoot

NL : Number of leaves

GRAPH-6A EFFECT OF 6 HRS ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (R-49).



GRAPH-6B EFFECT OF 6 HRS ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (R-49).



PERCENTAGE INCREASE

Statistical analysis of results shows that effect of 1 percent ether extract suspended in water is significant at 5 percent error probability.

Effect on Number of Lateral Roots :

Observations given in Table-6 and Graph-6A, 6B indicate that various concentrations of ether extract multiply number of lateral roots over control. Maximum number of laterals has been found in treatment with 1 percent ether extract suspended in water. Both higher or lower concentrations than 1 percent deplete number of laterals. The beneficial effect of extracts is maintained throughout observation periods.

The results were statistically analysed following analysis of variance method and observed increase in number of lateral roots has been found significant at 5 percent error probability.

Effect on Length of Shoot :

Results given in Table-6 and Graph-6A, 6B show that length of shoot increases to the maximum extent with 1 percent ether extract. Other concentrations (0.5, 2 and 5 percent) of ether extract although stimulatory are effective to lesser extent than 1 percent. The beneficial effect of treatments is maintained throughout experimental period.

Statistical analysis of data shows that increase in length of shoot with 1 percent over normal untreated seedlings is significant at 5 percent error probability.

Effect on Number of Leaves :

Observations given in Table-6 and Graph-6A, 6B are suggestive that there is a sustained beneficial effect of different concentrations (0.5, 1, 2 and 5 percent) of ether extract. However, treatment with 1 percent exercises maximum increase in number of leaves over control. Lowering or increase in concentration results a declining effect of extracts.

Results were statistically analysed following analysis of variance method and 1 percent ether extract has been found to be significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT WITH WATER EXTRACT :

Effect on Length of Main Root :

A perusal of Table-7 and Graph-7A, 7B indicate that while 0.5, 1 and 2 percent extracts promote length of main root over control, 5 percent extract marks a depletion in length of main root at the end of observations. However, 1 percent water extract has been distinctly stimulatory and promoted length of main root to the maximum extent.

TABLE - 7 :

EFFECT OF 12 HRS PRE-SOAKING SEED TREATMENT WITH WATER EXTRACT OF *Spirodella polyrhiza* ON GROWTH AND DEVELOPMENT OF MAIZE (R-49) SEEDLINGS (AVERAGE OF 50 REPLICATES)

WATER EXTRACT

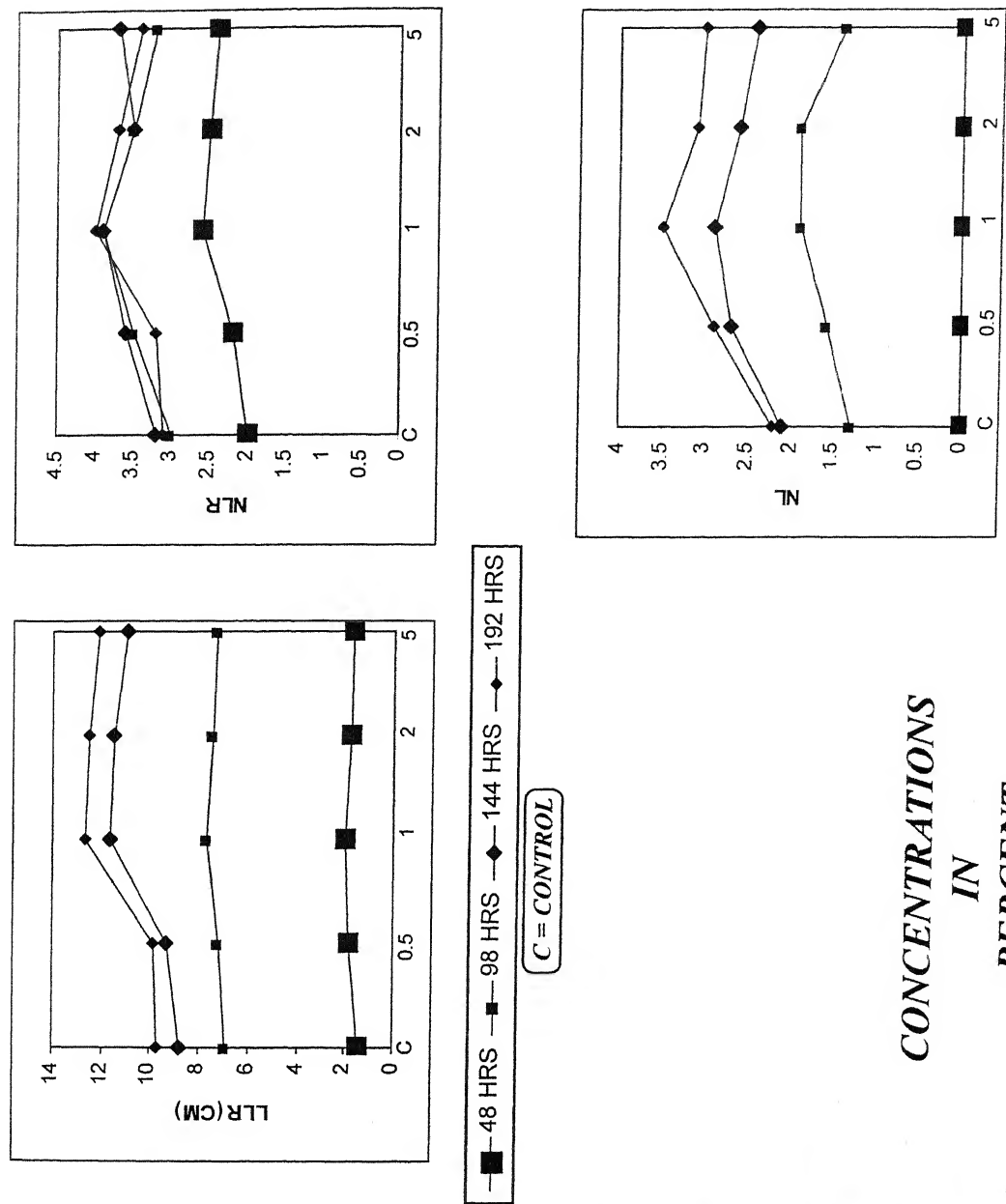
AGE OF SEED-LINGS IN HRS	LENGTH OF MAIN ROOT IN CM					AVERAGE LENGTH OF LATERAL ROOTS IN CM					NUMBER OF LATERAL ROOTS					LENGTH OF SHOOT IN CM					NUMBERS OF LEAVES				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
48	4.1	4.6	5.5	5.4	4.2	1.5	1.9	2.0	1.8	1.7	2.0	2.2	2.6	2.5	2.4	1.3	1.4	1.7	1.5	1.2	A	A	A	A	A
96	8.7	8.7	8.9	8.4	8.0	6.9	7.2	7.7	7.5	7.3	3.0	3.5	3.9	3.5	3.2	2.0	2.4	3.1	2.6	2.4	1.3	1.6	1.9	1.9	1.4
144	11.8	12.1	12.2	11.7	11.1	8.8	9.3	11.7	11.5	11.0	3.2	3.6	3.9	3.5	3.7	2.9	2.7	3.3	2.9	2.5	2.1	2.7	2.9	2.6	2.4
192	12.5	12.8	13.9	13.7	12.0	9.7	9.9	12.7	12.5	12.1	3.1	3.2	4.0	3.7	3.4	2.3	2.7	3.3	3.1	2.7	2.2	2.9	3.5	3.1	3.0
Difference calculated at 192 hrs	C.D. = 0.50					C.D. = 0.98					C.D. = 0.22					C.D. = 0.26					C.D. = 0.28				
	DIFF. 1% -C = 1.40					DIFF. 1% - C = 3.00					DIFF. 1%-C = 0.90					DIFF. 1%-C = 1.00					DIFF. 1%-C = 1.3				

ABBREVIATIONS USED : C = Control, C.D. = Critical Difference, A = Absent

***GRAPH NO.-7: EFFECT OF 12 HRS. WATER EXTRACT ON SEED-
LING GROWTH OF MAIZE (R-49).***

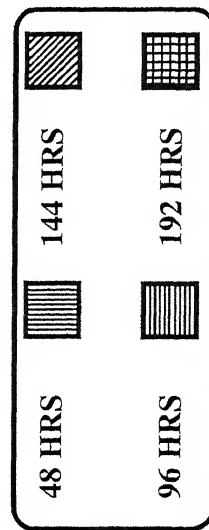
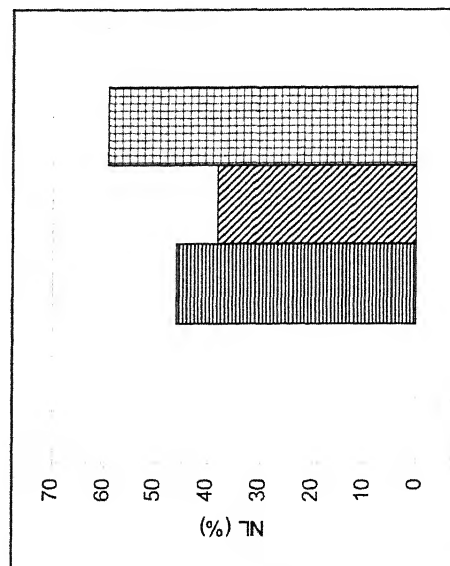
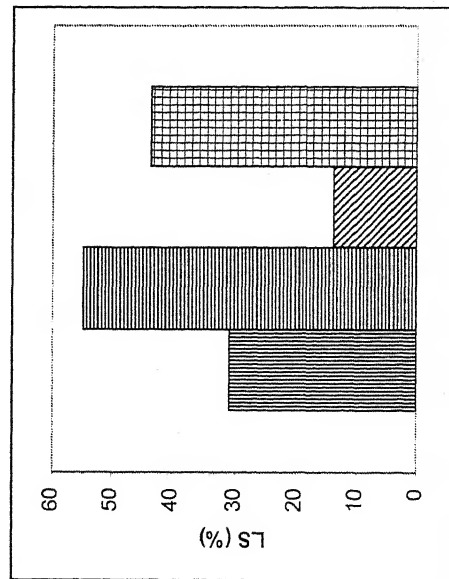
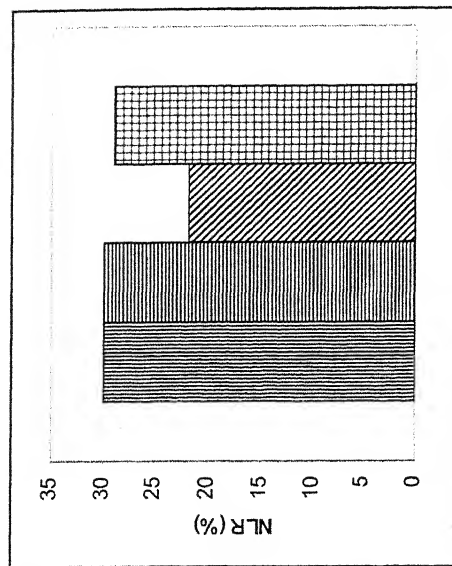
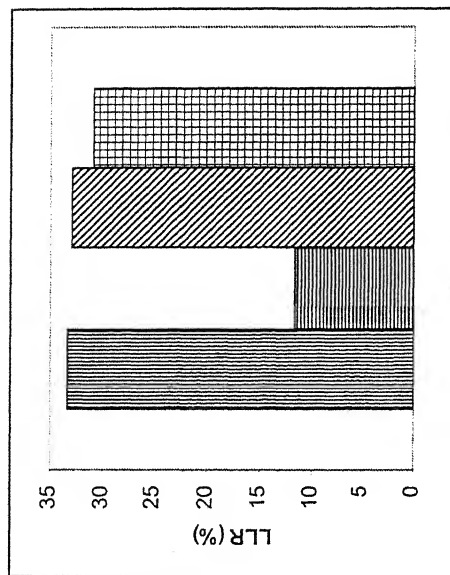
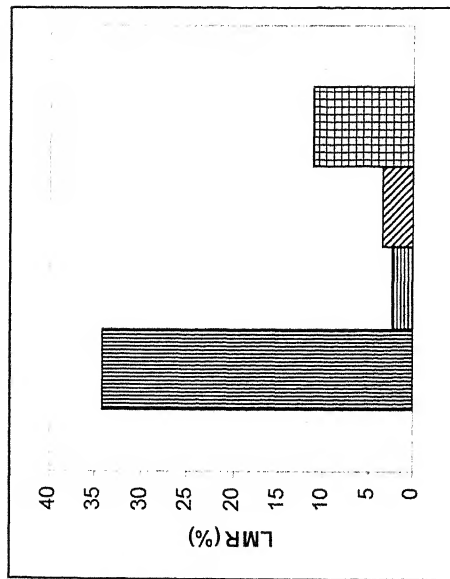
LMR : Length of main root
LLR : Length of lateral roots
NLR : Number of lateral roots
LS : Length of shoot
NL : Number of leaves

GRAPH-7A EFFECT OF 12 HRS WATER EXTRACT ON SEEDLING GROWTH OF MAIZE (R-49).



**CONCENTRATIONS
IN
PERCENT**

GRAPH-7B EFFECT OF 12 HRS WATER EXTRACT ON SEEDLING GROWTH OF MAIZE (R-49).



PERCENTAGE INCREASE

Statistical analysis of data suggests that observed increase in length of main root with 1 percent water extract is significant at 5 percent error probability.

Effect on Length of Lateral Roots :

A perusal of Table-7 and Graph-7A, 7B is indicative of a beneficial effect of *S. polyrhiza* ether extract suspended in water. The stimulatory effect has been maintained throughout the duration of experiment. Maximum length of lateral roots has been obtained in treatment with 1 percent. However, increase or decrease in concentration of extract applied gradually declines the beneficial effect. The effect of various concentrations of extracts is maintained.

Statistical analysis of data shows that observed increase with 1 percent water extract is significant at 5 percent error probability.

Effect on Number of Lateral Roots :

Results given in Table-7 and Graph-7A, 7B show that there is an increase in number of lateral roots from the beginning and the effect is maintained throughout the duration of experiment. While 1 percent extract exercises maximum increase in number of laterals, lowering or increase in concentration of extract correspondingly reduces the influence.

The data was statistically analysed following analysis of variance method and the effect of 1 percent water extract at 192 hrs has been found to be significant at 5 percent error probability.

Effect on Length of Shoot :

Results given in Table-7 and Graph-7A, 7B show that length of shoot increases to the maximum extent with 1 percent water extract. Other concentrations (0.5, 2 and 5 percent) of water extract although stimulatory are effective to lessar extent than 1 percent. The beneficial effect of treatment is maintained throughout experimental period.

Statistical analysis of data shows that increase in length of shoot with 1 percent over normal untreated seedling is significant at 5 percent eroor probability.

Effect on Number of Leaves :

A perusal of Table-7 and Graph-7A, 7B shows that while 0.5, 1 and 2 percent stimulate formation of number of leaves from the beginning 5 percent treatment to mark a depletion initially at 96 hrs, it gradually recovers later on at 144 hrs and finally exercises an increase at 192 hrs. Treatment with 1 percent extract increases number of leaves over control to the maximum effect. The beneficial influence of 0.5, 1 and

2 percent water extract is maintained throughout the duration of experiment.

Statistical analysis of data shows that observed increase in number of leaves is significant at 192 hrs.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT WITH ETHER EXTRACT :

Effect on Length of Main Root :

An examination of data given in Table-8 and Graph-8A, 8B show that there is an increase in length of main root with various concentrations (0.5, 1, 2 and 5 percent) of ether extract suspended in water. The beneficial effect is maintained throughout the duration of experiment. Treatment with 1 percent ether increases length of main root to the maximum extent. Lowering as well as increase in concentration of ether extract suspended in water gradually reduces the effects.

Results obtained were statistically analysed and the data showed that observed increase with 1 percent ether extract is significant.

Effect on Length of Lateral Roots :

Data on response of length of lateral roots to *S. polyrhiza* ether extract has been given in Table-8 and Graph-

TABLE - 8 : EFFECT OF 12 HRS PRE-SOAKING SEED TREATMENT WITH ETHER EXTRACT OF *Spirodella polyrhiza* ON GROWTH AND DEVELOPMENT OF MAIZE (R-49) SEEDLINGS (AVERAGE OF 50 REPLICATES)

ETHER EXTRACT

AGE OF SEED-LINGS IN HRS	LENGTH OF MAIN ROOT IN CM					AVERAGE LENGTH OF LATERAL ROOTS IN CM					NUMBER OF LATERAL ROOTS					LENGTH OF SHOOT IN CM					NUMBERS OF LEAVES				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
48	4.7	4.8	5.3	5.0	4.9	1.4	1.7	1.9	1.8	1.4	2.1	2.3	3.1	2.9	2.0	1.7	1.9	2.0	1.9	1.6	A	A	A	A	A
96	7.9	8.7	10.6	9.8	8.6	7.0	7.2	9.5	8.7	8.0	3.0	3.4	3.6	3.4	3.0	2.0	2.6	3.0	2.4	2.4	1.6	1.7	1.9	1.8	1.8
144	12.1	12.7	13.0	12.8	12.3	9.3	10.7	11.0	11.8	11.2	3.3	3.6	3.9	3.7	3.4	2.1	2.6	3.1	2.7	2.9	2.8	2.8	3.0	2.8	2.7
192	12.9	13.1	13.9	13.3	12.6	9.9	10.9	12.9	12.8	11.9	3.6	3.8	3.9	3.8	3.7	2.3	2.9	3.3	2.7	2.6	2.9	3.1	3.6	3.0	2.9
Difference calculated at 192 hrs	C.D.= 0.56 DIFF. 1% -C = 1.00					C.D. = 0.80 DIFF. 1% - C = 3.00					C.D.= 0.24 DIFF. 1%-C = 0.30					C.D. = 0.24 DIFF. 1%-C = 1.00					C.D. = 0.18 DIFF. 1%-C = 0.70				

ABBREVIATIONS USED : C = Control, C.D. = Critical Difference, A = Absent

GRAPH NO.-8: EFFECT OF 12 HRS. ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (AZAD UTTAM).

LMR : Length of main root

LLR : Length of lateral roots

NLR : Number of lateral roots

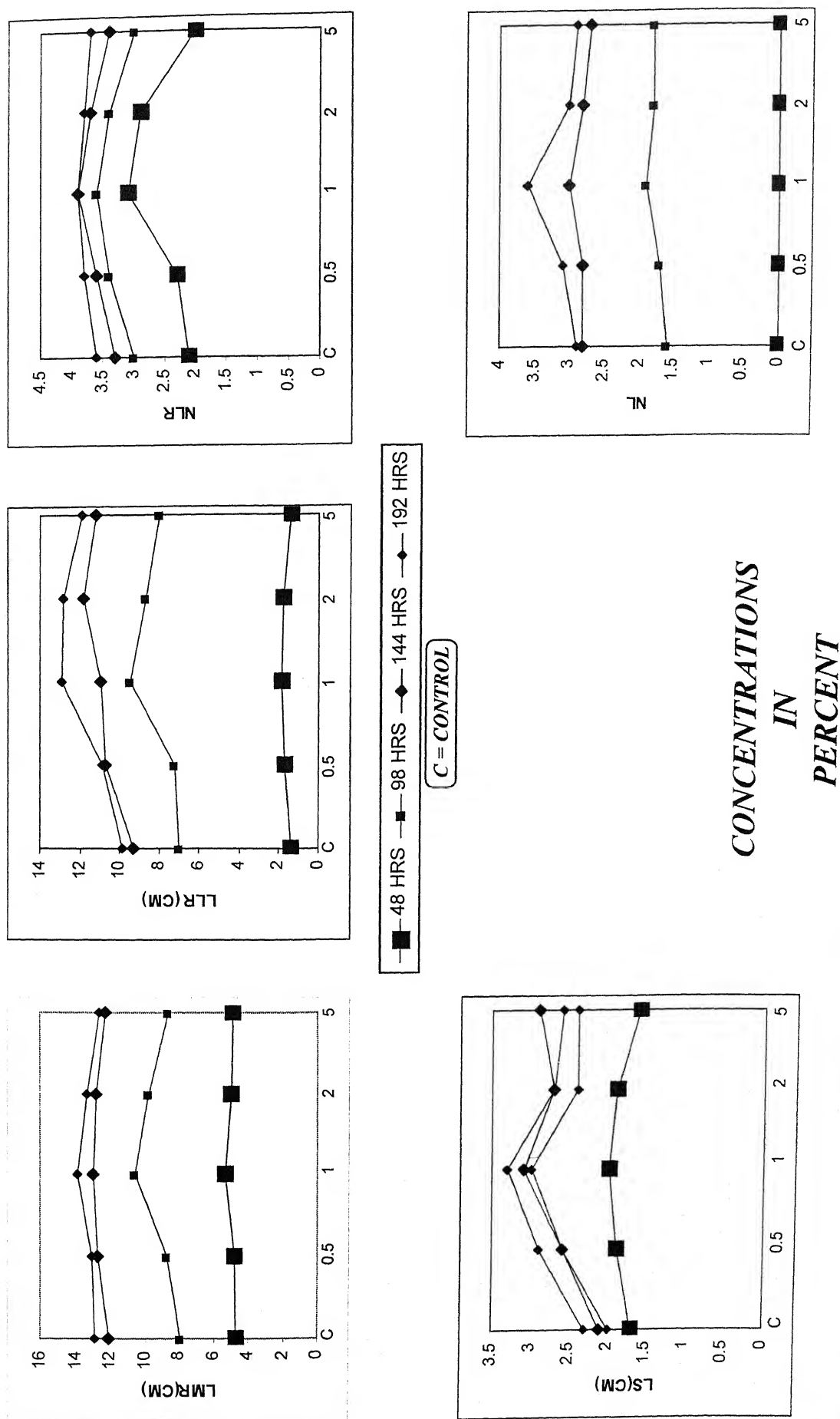
LS : Length of shoot

NL : Number of leaves

***GRAPH NO.-8: EFFECT OF 12 HRS. ETHER EXTRACT ON SEED-
LING GROWTH OF MAIZE (AZAD UTTAM).***

LMR : Length of main root
LLR : Length of lateral roots
NLR : Number of lateral roots
LS : Length of shoot
NL : Number of leaves

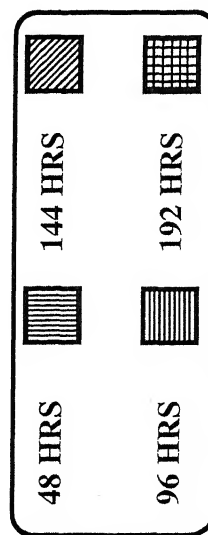
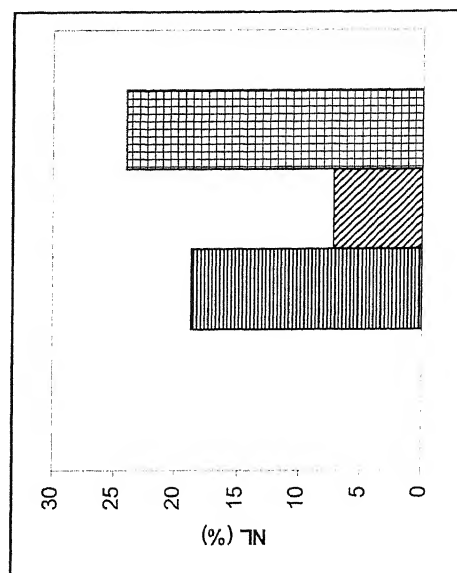
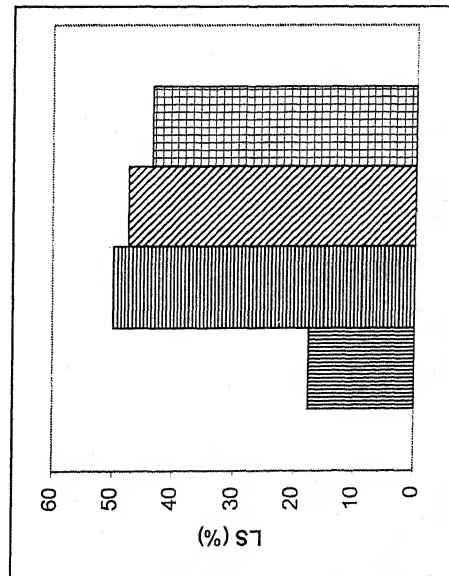
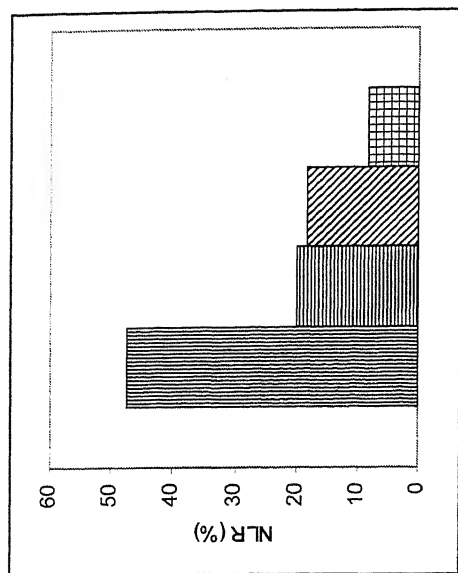
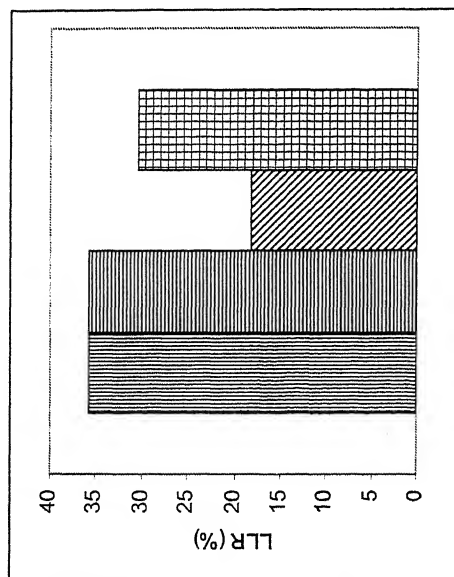
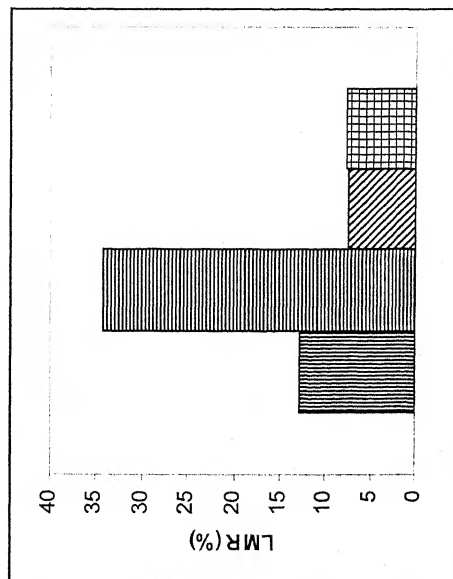
GRAPH-8A EFFECT OF 12 HRS ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (R-49).



CONCENTRATIONS
IN
PERCENT

GRAPH-8B

EFFECT OF 12 HRS ETHER EXTRACT ON SEEDLING GROWTH OF MAIZE (R-49).



PERCENTAGE INCREASE

8A, 8B. Result indicates an overall betterment in length of lateral over control with 1 percent treatment. The beneficial effect of various concentrations of ether extract suspended in water has been maintained throughout observation period.

Statistical analysis of results shows that effect of 1 percent ether extract is significant at 5 percent error probability.

Effect on Number of Lateral Roots :

Observations given in Table-8 and Graph-8A, 8B indicate that various concentrations of ether extract suspended in water multiply number of lateral roots over control. Maximum number of laterals has been found in treatment with 1 percent ether extract. Both higher or lower concentrations than 1 percent deplete number of laterals. The beneficial effect of extracts is maintained throughout observation periods.

The results were statistically analysed following analysis of variance method and observed increase in number of lateral roots has been found significant at 5 percent error probability.

Effect on Length of Shoot :

Results given in Table-8 and Graph-8A, 8B show that length of shoot increases to the maximum extent with 1 percent ether extract. Other concentrations (0.5, 2 and 5 percent) of ether extract although stimulatory are effective to

lesser extent than 1 percent. The beneficial effect of treatments is maintained throughout experimental period.

The statistical analysis of data shows that increase in length of shoot with 1 percent over normal untreated seedlings is significant at 5 percent error probability.

Effect on Number of Leaves :

Observations given in Table-8 and Graph-8A, 8B are suggestive that there is a sustained beneficial effect of different concentrations (0.5, 1, 2 and 5 percent) of ether extract. However, treatment with 1 percent exercises maximum increase in number of leaves over control. Lowering or increase in concentrations results a declining effect of extracts.

Results were statistically analysed following analysis of variance method and 1 percent ether extract has been found to be significant at 5 percent error probability.

CHAPTER 2

STUDIES ON EFFECT OF
Spirodella polyrhiza EXTRACTS
ON GROWTH, DEVELOPMENT
AND YIELD OF MAIZE.

STUDIES ON EFFECT OF *Spirodella polyrhiza* EXTRACTS ON GROWTH, DEVELOPMENT AND YIELD OF MAIZE

The influence of pre-soaking seed treatments for 6 and 12 hrs with water extract and ether extract suspended in water of *S. polyrhiza* has been studied on the growth and yield of two varieties of maize (Azad Uttam and R-49) grown under normal field conditions. Effect of 5 percent water and ether extracts on variety Azad Uttam and 1 percent water and ether extract on variety R-49 has been studied as these concentrations exercised sustained improvement on juvenile seedling growth. Effect of these concentrations on subsequent mature plant growth and development appeared to be of proven significance. The observations are given below.

RESPONSE OF MAIZE VARIETY AZAD UTTAM :

INFLUENCE OF 6 HRS PRE-SOAKING SEED TREATMENT ON VEGETATIVE GROWTH AND DEVELOPMENT :

Effect on Height of Plants :

Results on influence of 6 hrs pre-soaking seed treatment with 5 percent water and ether extract of *S. polyrhiza* are given in Table-9 and Graph-9A, 9B. An examination of data shows that both 5 percent water and ether extract promote

PHOTO - 5: SHOWING EFFECT OF VARIOUS TREATMENT WITH EXTRACTS OF *Spirodella polyrhiza* PLANTS ON MAIZE CROP.

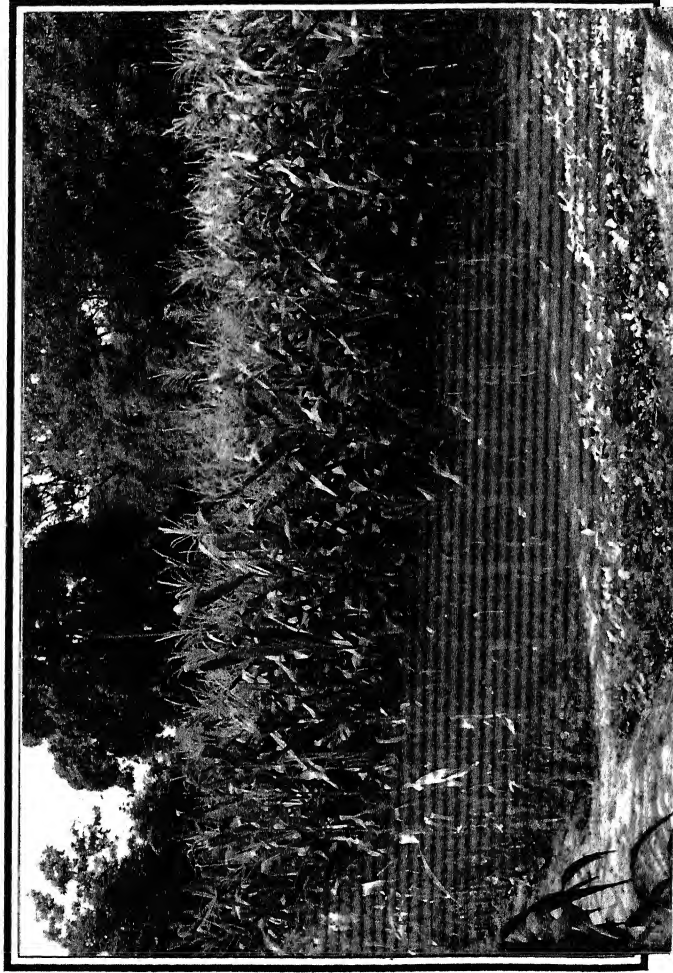


TABLE - 9 :

EFFECT OF 6 HRS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON GROWTH AND DEVELOPMENT OF MATURE MAIZE (AZAD UTTAM) PLANTS (AVERAGE OF 50 REPLICATES)

AGE OF PLANTS	HEIGHT OF PLANTS IN CM		NUMBER OF LEAVES PER PLANT			LENGTH OF LEAF IN CM			BREATH OF LEAVES IN CM			
	C	5%W	5%EW	C	5%W	5%EW	C	5%W	5%EW	C	5%W	5%EW
15 days	11.3	12.3	12.4	6.0	7.6	7.9	36.2	37.5	39.0	2.1	2.3	2.5
30 days	45.1	49.3	51.9	10.8	11.9	12.0	76.3	83.1	85.9	5.2	5.9	6.0
45 days	143.9	154.6	158.8	12.1	12.9	13.3	77.9	83.6	90.8	5.4	6.0	6.1

C.D. = 8.11

DIFFERENCE:

5% W-C = 10.7

DIFFERENCE:

5% EW-C = 14.9

C.D. = 0.55

DIFFERENCE:

5% W-C = 0.80

DIFFERENCE:

5%EW-C = 1.20

C.D. = 6.13

DIFFERENCE:

5% W-C = 5.70

DIFFERENCE:

5%EW-C = 12.9

C.D. = 0.32

DIFFERENCE:

5% W-C = 0.60

DIFFERENCE:

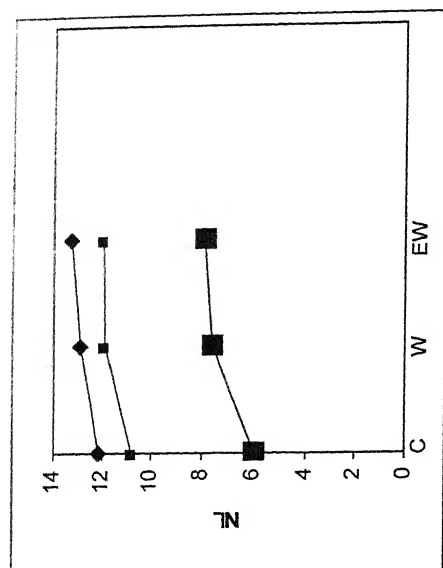
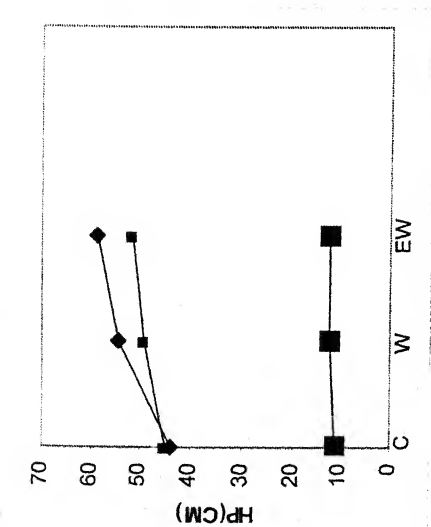
5%EW-C = 0.70

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

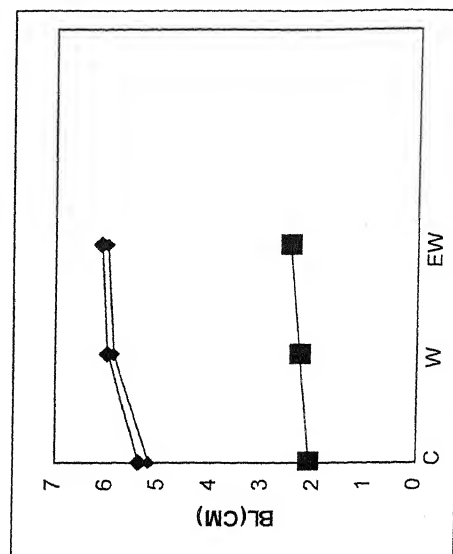
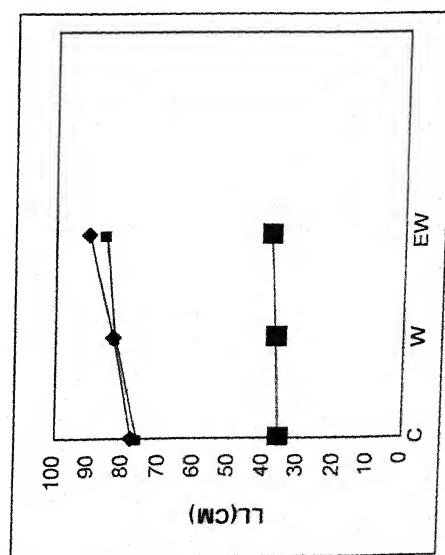
***GRAPH NO.-9: EFFECT OF 6 HRS. TREATMENT ON MATURE
PLANT GROWTH OF MAIZE (AZAD UTTAM).***

HP : Height of plant
NL : Number of leaf
LL : Length of leaf
BL : Breadth of leaf

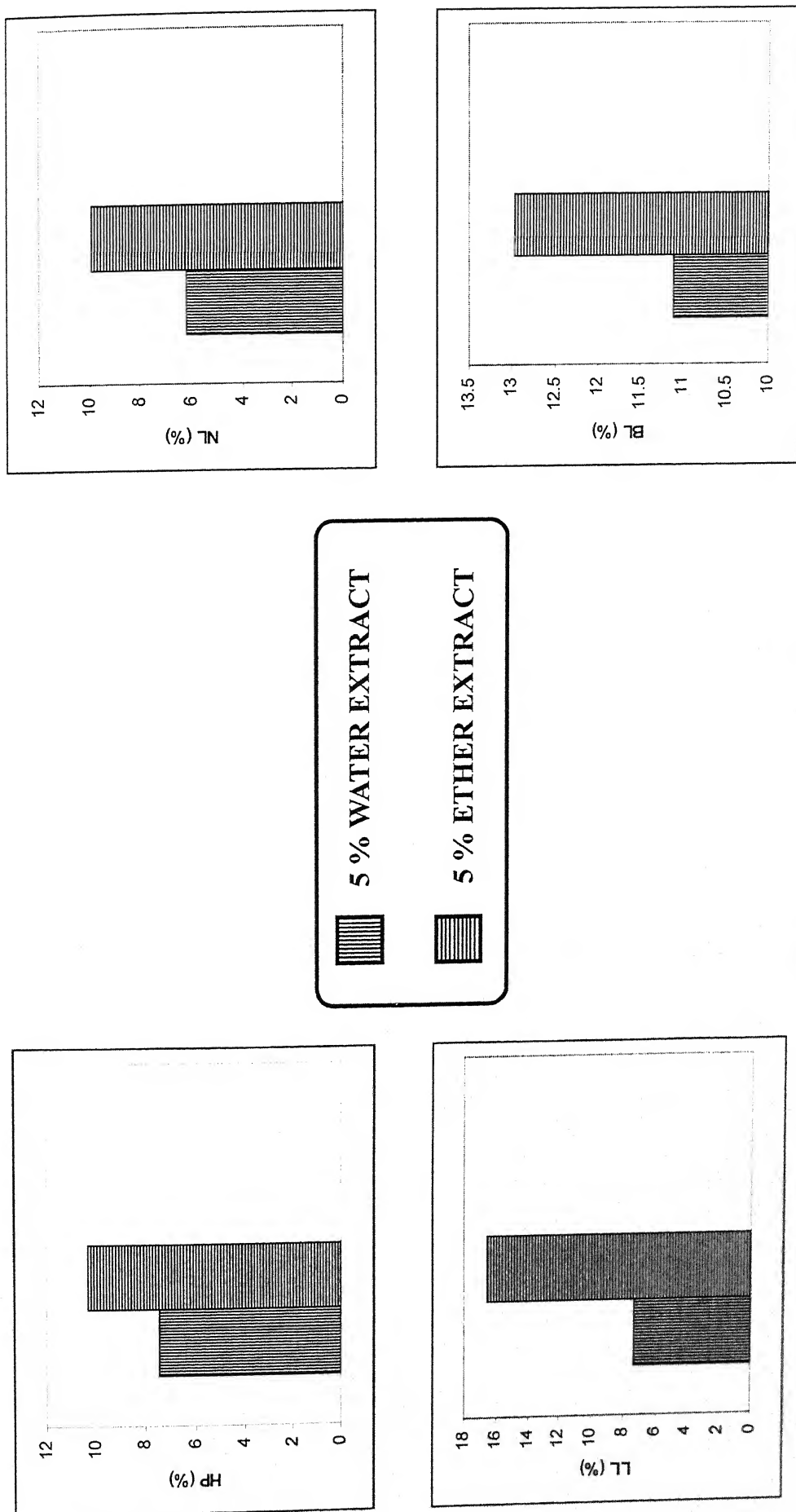
GRAPH-9A EFFECT OF 6 HRS TREATMENT ON MATURE PLANT GROWTH OF MAIZE (AZAD UTTAM).



—■— 15 DAYS
 - - - ■ - - 30 DAYS
 —◆— 45 DAYS
 C= CONTROL
 W= 5% WATER EXTRACT
 EW= 5% ETHER EXTRACT

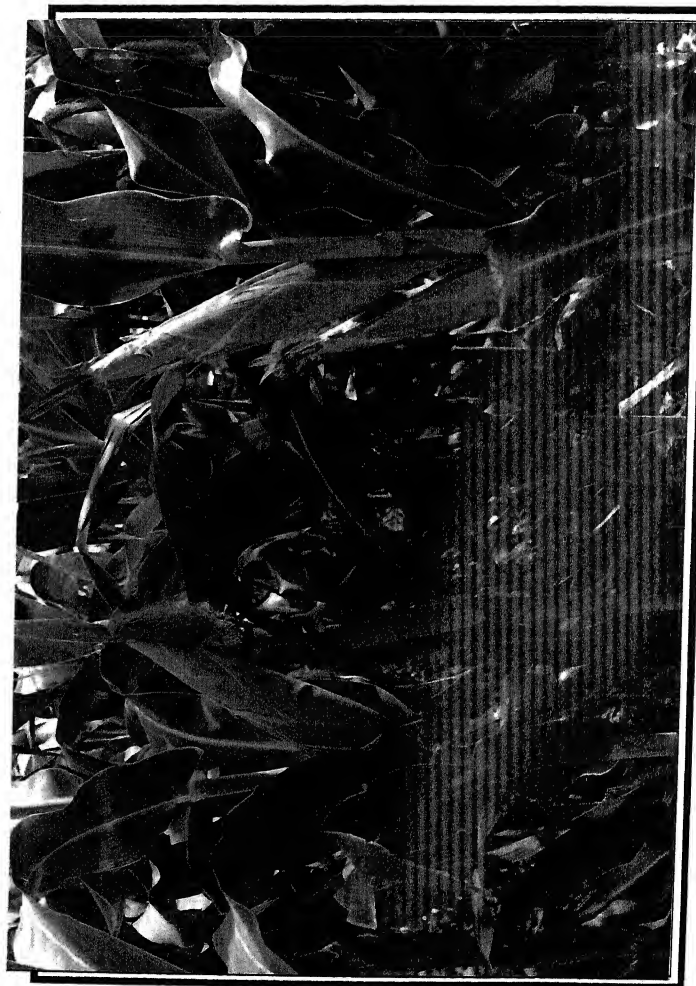


GRAPH-9B EFFECT OF 6 HRS TREATMENT ON MATURE PLANT GROWTH OF MAIZE (AZAD UTTAM).



PERCENTAGE INCREASE

PHOTO - 6: EFFECT OF 12 HRS. PRE-SOAKING SEED TREATMENT OF *Spirodella polyrhiza* EXTRACT ON MATURE PLANT GROWTH OF MAIZE (AZAD UTTAM).



Control

5%ETHER WATER-EXTRACT

height of plants over control but comparatively ether extract is more beneficial. The beneficial influence of treatments is maintained through out the duration of crop.

The data has been statistically analysed following analysis of variance method. Observed increases with 5 percent water and ether extracts are significant at 5 percent error probability.

Effect on Number of Leaves :

Observations given in Table-9 and Graph-9A, 9B are indicative of increasing number of leaves from the beginning of experiment and the beneficial effect is maintained during subsequent observations. It has been observed that 5 percent ether extract is more effective than 5 percent water extract.

The data has been statistically analysed and observed increase with 5 percent ether extract is significant at 5 percent error probability.

Effect on Length of Leaf :

A perusal of Table-9 and Graph-9A, 9B show that length of leaves enlarges with 5 percent water and 5 percent ether extracts. A sustained beneficial effect on length of leaves has been observed throughout the duration of the crop. The effect of ether extract is comparatively more pronounced than water extract.

Statistical analysis of results shows that observed increase with 5 percent ether extract is statistically significant after 45 days of sowing but effect of water extract is insignificant at 5 percent error probability.

Effect on Breadth of Leaves :

Observations on the effect of *S. polyrhiza* extracts on breadth of leaves are given in Table-9 and Graph-9A, 9B. The data shows an overall increase in breadth of leaves in treatments with 5 percent water and ether extract. The beneficial effect is maintained throughout the duration of crop. However, effect of 5 percent ether extracts is more pronounced than water extract.

The data has been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

PHOTO - 7: EFFECT OF 12 HRS. PRE-SOAKING SEED TREATMENT OF *Spirodella polyrhiza* EXTRACT ON MATURE PLANT GROWTH OF MAIZE (R-49).



Control

1%ETHER WATER-EXTRACT

TABLE - 10 :

EFFECT OF 12 HRS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON GROWTH AND DEVELOPMENT OF MATURE MAIZE (AZAD UTTAM) PLANTS (AVERAGE OF 50 REPLICATES)

AGE OF PLANTS	HEIGHT OF PLANTS IN CM		NUMBER OF LEAVES PER PLANT			LENGTH OF LEAF IN CM		BREADTH OF LEAVES IN CM				
	C	5%WV	5%EW	C	5%W	5%EW	C	5%WV	5%EW	C	5%W	5%EW
15 days	10.2	11.1	11.9	6.6	7.9	8.1	33.00	35.1	41.4	2.4	2.7	3.0
30 days	51.1	52.2	53.6	10.6	12.2	12.9	79.3	79.6	83.1	5.3	6.4	6.4
45 days	154.2	157.3	170.6	11.5	12.3	13.1	79.4	80.2	83.4	6.8	6.9	7.5

Difference Calculated at 45 days	C.D. = 10.12	C.D. = 0.63	C.D. = 3.01	C.D. = 0.614
DIFFERENCE:	DIFFERENCE:	DIFFERENCE:	DIFFERENCE:	DIFFERENCE:
5% W-C = 3.1	5% W-C = 0.80	5% W-C = 0.80	5% W-C = 0.80	5% W-C = 0.10
DIFFERENCE:	DIFFERENCE:	DIFFERENCE:	DIFFERENCE:	DIFFERENCE:
5% EW-C = 16.4	5%EW-C = 1.60	5%EW-C = 4.00	5%EW-C = 0.70	

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

***GRAPH NO.-10: EFFECT OF 12 HRS. TREATMENT ON MATURE
PLANT GROWTH OF MAIZE (AZAD UTTAM).***

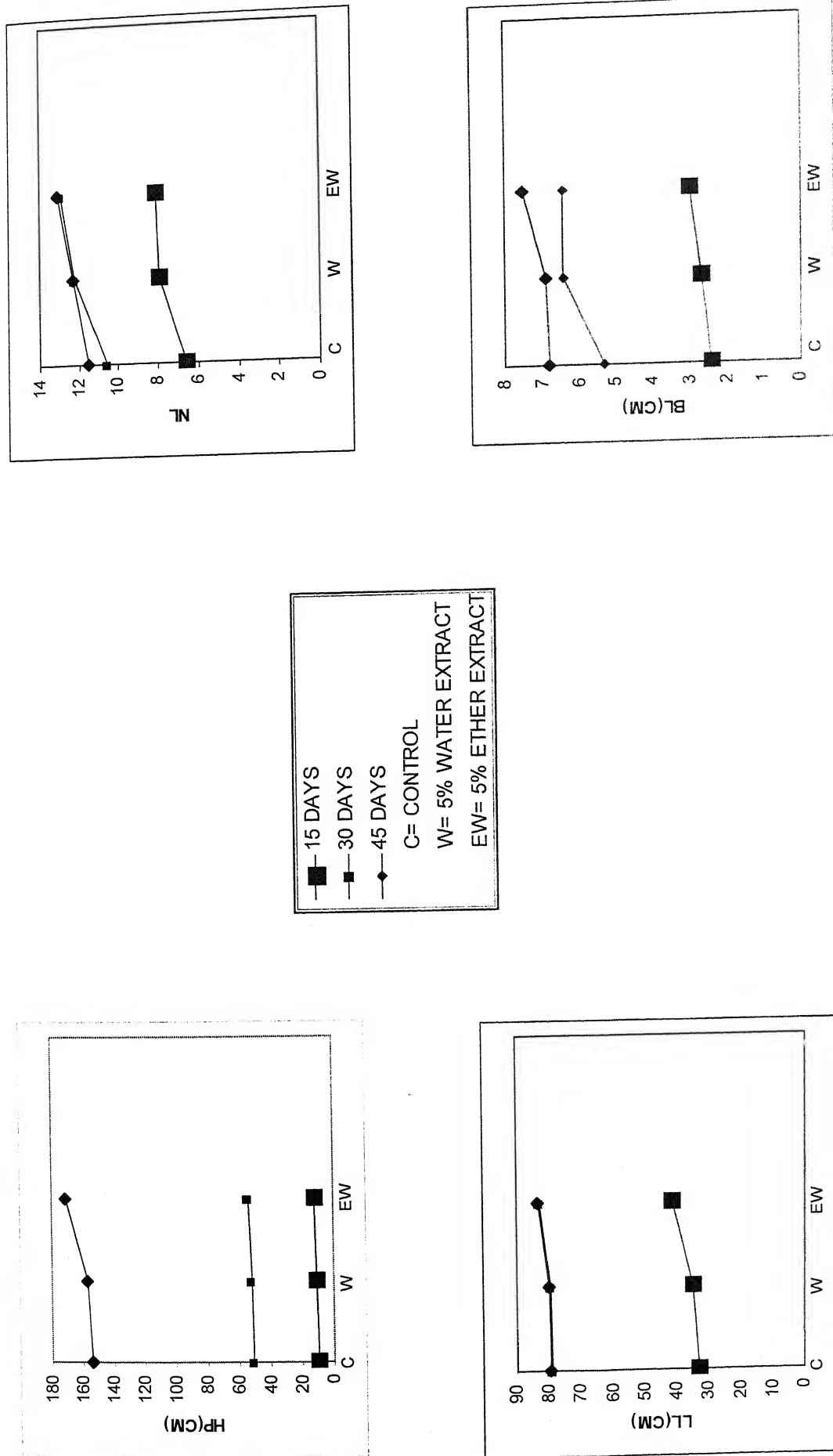
HP : Height of plant

NL : Number of leaf

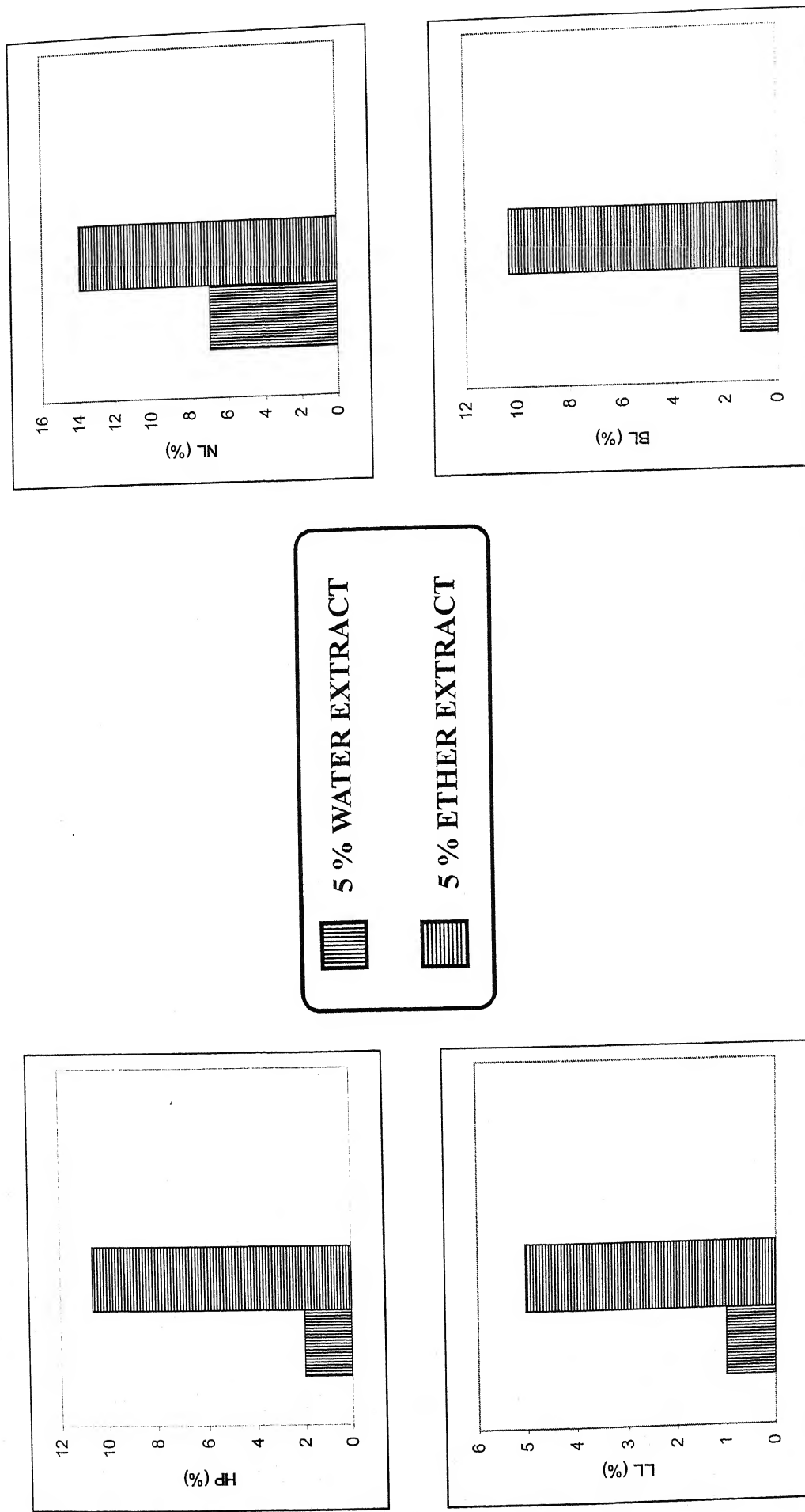
LL : Length of leaf

BL : Breadth of leaf

GRAPH-10A EFFECT OF 12 HRS TREATMENT ON MATURE PLANT GROWTH OF MAIZE (AZAD UTTAM).



GRAPH-10B EFFECT OF 12 HRS TREATMENT ON MATURE PLANT GROWTH OF MAIZE (AZAD UTTAM).



PERCENTAGE INCREASE

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON VEGETATIVE GROWTH AND DEVELOPMENT :

Effect on Height of Plants :

Results on influence of 12 hrs pre-soaking seed treatment with 5 percent water and ether extract of *S. polyrhiza* are given in Table-10 and Graph-10A, 10B. An examination of data shows that both 5 percent water and ether extract promote height of plants over control but comparatively ether extract is more beneficial. The beneficial influence of treatments is maintained throughout the duration of crop.

The data has been statistically analysed following analysis of variance method. Observed increase with 5 percent ether extract is significant at 5 percent error probability.

Effect on Number of Leaves :

Observations given in Table-10 and Graph-10A, 10B are indicative of increasing number of leaves from the beginning of experiment and the beneficial effect is maintained during subsequent observations. It has been observed that 5 percent ether extract is more effective than 5 percent water extract.

The data has been statistically analysed and observed increase with 5 percent ether extract is significant at 5 percent error probability.

Effect on Length of Leaf :

A perusal of Table-10 and Graph-10A, 10B show that length of leaves enlarges with 5 percent water and 5 percent ether extracts. A sustained beneficial effect on length of leaves has been observed throughout the duration of the crop. The effect of ether extract is comparatively more pronounced than water extract.

Statistical analysis of results shows that observed increase with 5 percent ether extract is statistically significant after 45 days of sowing but effect of water extract is insignificant.

Effect on Breadth of Leaves :

Observation on the effect of *S. polyrhiza* extracts on breadth of leaves are given in Table-10 and Graph-10A, 10B. The data shows an overall increase in breadth of leaves in treatments with 5 percent water and ether extracts. The beneficial effect is maintained throughout the duration of crop.

However, effect of 5 percent ether extract is more pronounced than water extract.

The data has been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant.

TABLE - 11 :

EFFECT OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON GROWTH AND DEVELOPMENT OF MATURE MAIZE (AZAD UTTAM) PLANTS (AVERAGE OF 50 REPLICATES)

PRE-SOAK- ING PERIOD OF SEEDS	FRESH VEGETATIVE FOLIAGE WEIGHT PER PLANT IN GMS		FRESH WEIGHT OF MALE INFLORESCENCE PER PLANT IN GMS		NUMBER OF FLORAL BRANCHES PER MALE INFLORESCENCE		NUMBER OF FRUITS PER PLANT				
	5%EW		5%EW		5%EW		5%EW				
	C	5%W	C	5%W	C	5%W	C	5%W	5%EW		
6 hrs	275	282	290	6.0	6.1	12	13	15	1.5	1.6	1.7
12 hrs	280	299	302	6.1	6.2	13	15	17	1.6	1.7	1.9

CD = 1434

C.D. = .1434

C.D. = 1.434

C.D. = 0.25

C.D. = 14.98

6 hrs treatment
Diff.5% W-C = 0.1
Diff.5% EW-C = 0.02

6 hrs treatment
Diff.5% W-C = 1
Diff.5% EW-C = 3.00

6 hrs treatment
Diff.5%W -C = 0
Diff.5% EW-C = 0.1

6 hrs treatment
Diff.5%W -C = 7
5% EW-C = 15

Statistical

Analysis

12 hrs treatment
Diff.5% W-C = 0.1
Diff.5% EW-C = 0.3

12 hrs treatment
Diff.5% EW-C = 2
Diff.5% EW-C = 4

12 hrs treatment
Diff.5% W-C = 0.1
Diff.5% EW-C = 0.3

12 hrs treatment
Diff.5% W-C = 19
Diff.5% EW-C = 22

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

***GRAPH NO.-11: EFFECT OF PRE-SOAKING SEED TREATMENT ON
VEGETATIVE PRODUCTION AND YIELD OF MAIZE
(AZAD UTTAM) PLANTS.***

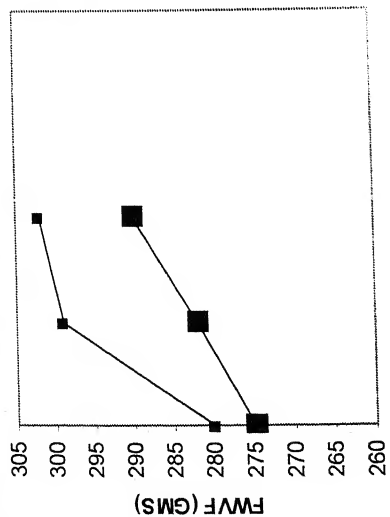
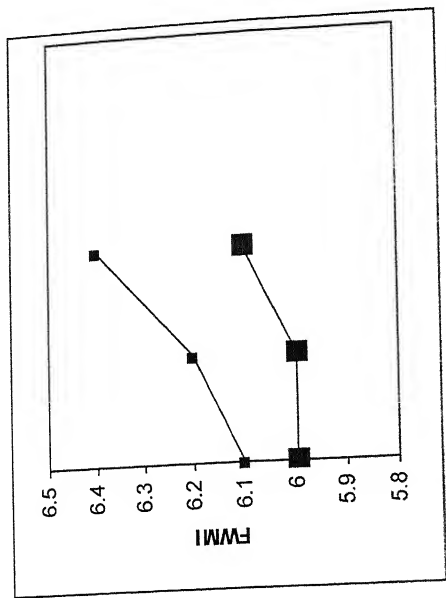
FWVF : Fresh vegetative foliage weight

FWMI : Fresh weight of male inflorescence

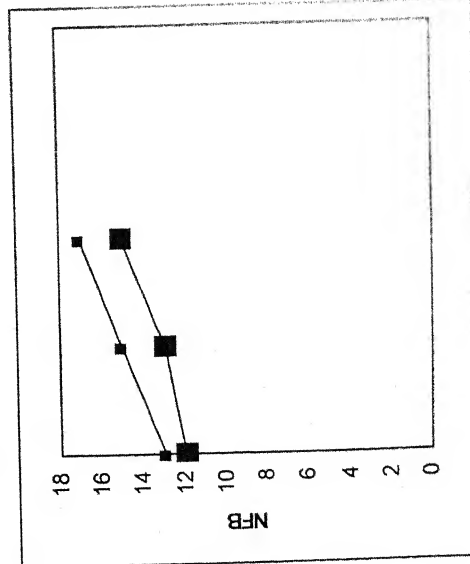
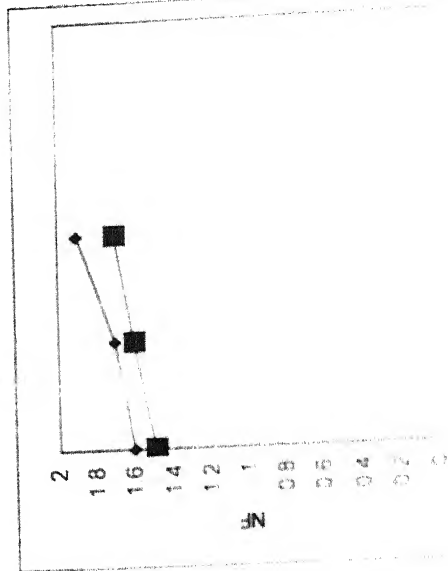
NFB : Number of floral branches per male inflorescence

NF : Number of fruits

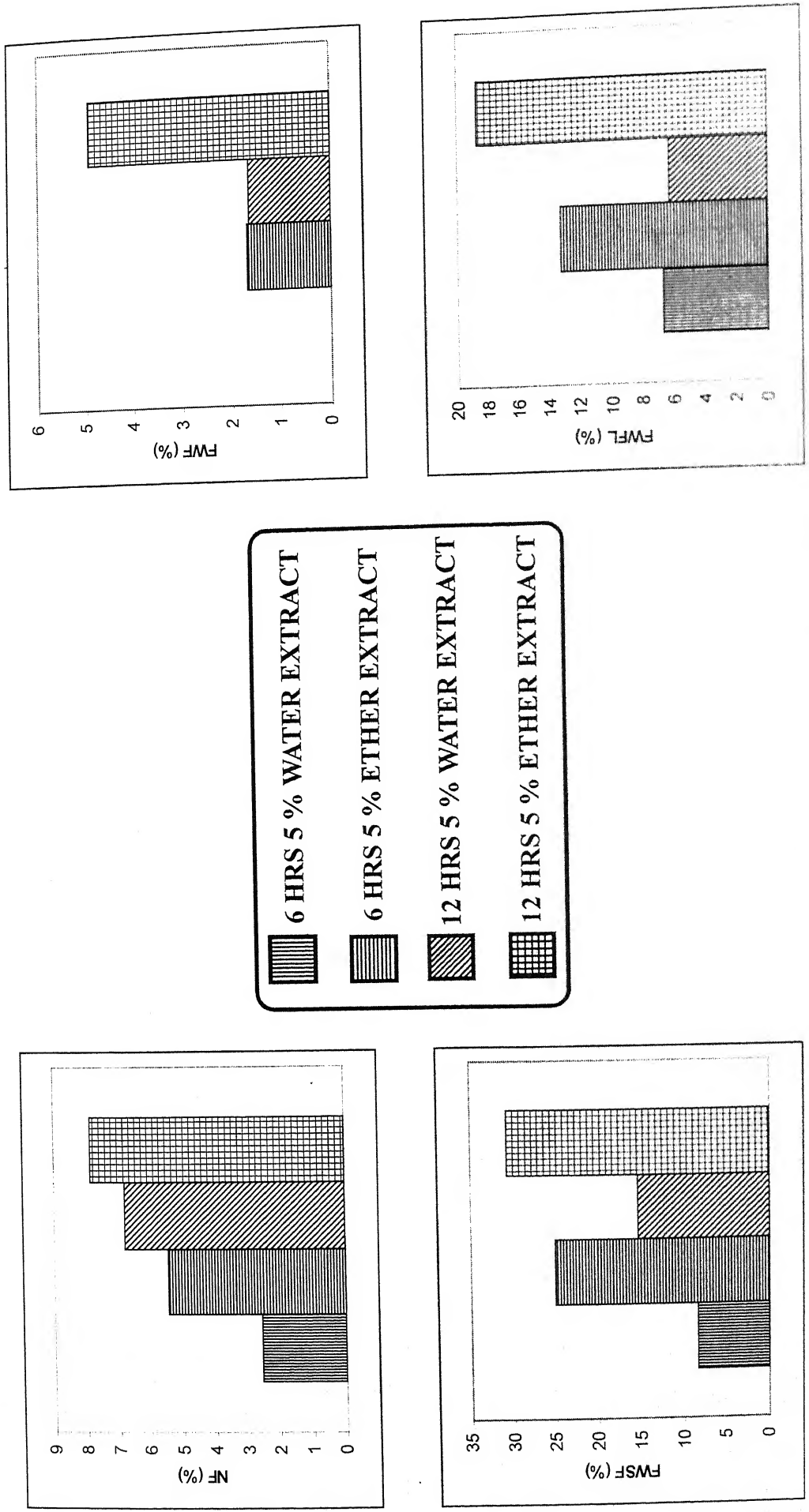
GRAPH-11A EFFECT OF PRE-SOAKING SEED TREATMENT ON VEGETATIVE PRODUCTION & YIELD OF MAIZE (AZAD UTTAM) PLANTS.



■ 6 HRS PRESOAKING
 ■ 12 HRS PRESOAKING
 C = CONTROL
 W = 5% WATER EXTRACT
 EW = 5% ETHER EXTRACT



GRAPH-11B EFFECT OF PRE-SOAKING SEED TREATMENT ON YIELD OF MAIZE (AZAD UTTAM) PLANT.



PERCENTAGE INCREASE

INFLUENCE ON FRESH WEIGHTS OF FOLIAGE AND MALE INFLORESCENCE, NUMBER OF BRANCHES, AND FRUITS :

Effect on Fresh Vegetative Foliage Weight :

Results given in Table-11 and Graph-11A, 11B on weight of fresh vegetative foliage shows that influence of 5 percent water and ether extracts increase fresh weight over control but effect of ether extract is more pronounced. However, increase in weight with 12 hrs pre-soaking treatment is more beneficial than 6 hrs.

Statistical analysis of data shows that only effect of 5 percent ether extract and 12 hrs treatment is significant at 5 percent error probability.

Effect on Fresh Weight of Male Inflorescence :

A perusal of Table-11 and Graph-11A, 11B show that treatment with 6 hrs is ineffective to multiply fresh weight of inflorescence, however, a significant increase with 5 percent water and ether extract has been witness. The effect of later is more conspicuous.

Results were statistically analysed and the observed increases with treatments have been found to be insignificant at 5 percent error probability.

PHOTO - 8: SHOWING EFFECT OF 6 HRS. PRE-SOAKING SEED
TREATMENT WITH *Spirodella polyrhiza* EXTRACT ON
YIELD OF MAIZE (AZAD UTTAM)



Control

5%ETHER WATER-EXTRACT

Effect on Number of Floral Branches in Inflorescence :

Observation given in Table-11 and Graph-11A, 11B show that treatments with 5 percent water and ether extracts exercise beneficial effect and increase number of branches per male inflorescence. However, effect of 5 percent ether extract and 12 hrs pre-soaking treatment exercises maximum effect.

Statistical analysis shows that observed increase with 12 hrs pre-soaking treatment with 5 percent ether extract is significant 5 percent error probability.

Effect on Number of Fruits Per Plant :

A perusal of Table-11 and Graph-11 shows that effect of 12 hrs treatment is more pronounced than 6 hrs treatment. However, 5 percent ether extract and 12 hrs treatment is maximum in effectiveness.

The data has been statistically analysed following analysis of variance method. Observed increase with 5 percent ether extract and 12 hrs treatment is statistically significant.

INFLUENCE ON YIELD OF PLANTS :

Effect on Number of Fruits :

An examination of Table-12 and Graph-12A, 12B show that treatments with 5 percent water and ether extracts for

6 and 12 exercise an increase in number of fruits per plant. Ether extracts of 12 hrs treatments are more effective. However, maximum number of fruits appeared with 5 percent ether extract and 12 hrs treatment.

Statistical analysis of data shows observed increase in 12 hrs pre-soaking treatment with 5 percent ether extract is significant at 5 percent error probability.

Effect on Fresh Weight of Fruits :

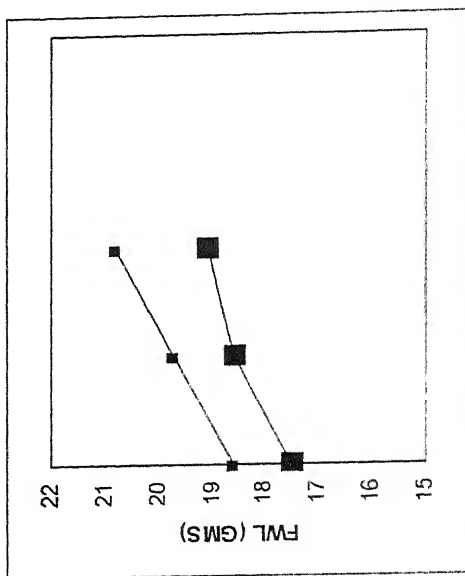
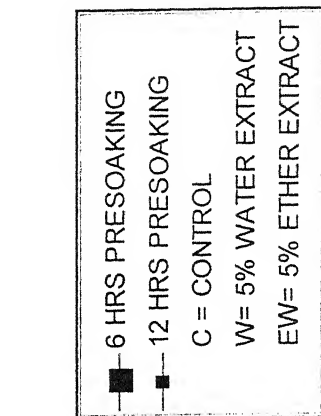
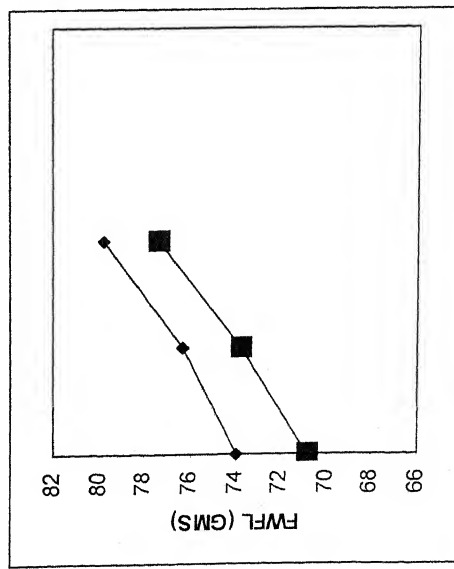
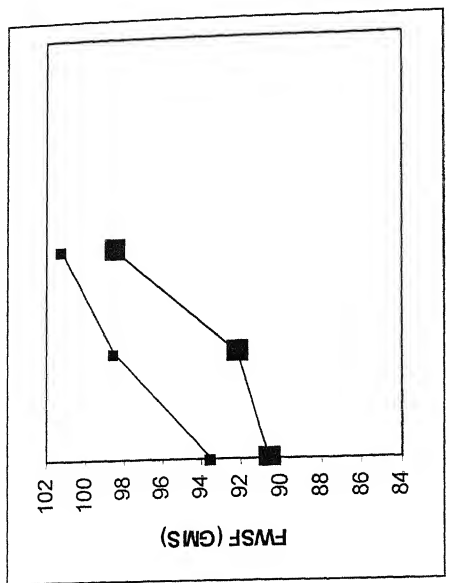
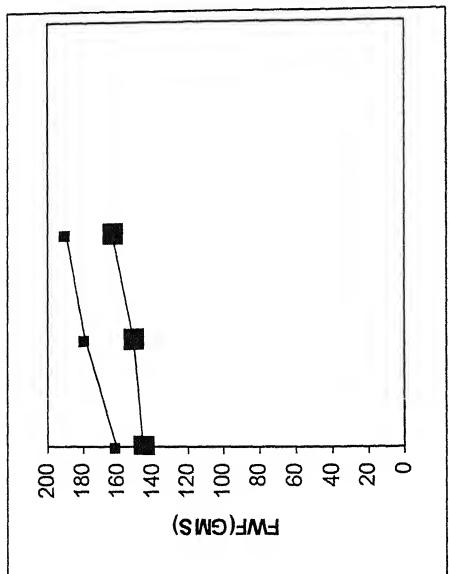
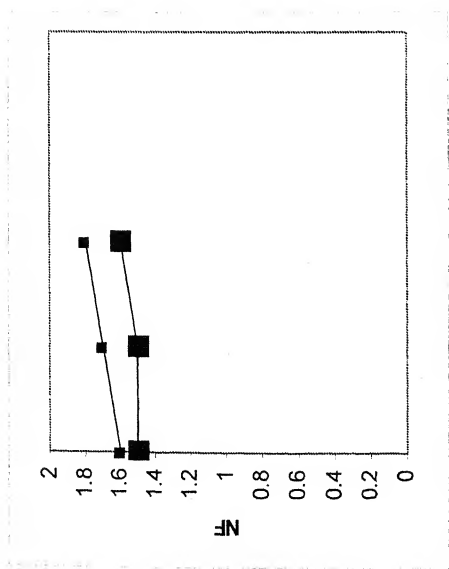
Results given in Table-12 and Graph-12A, 12B on weight of fruits per plant show that influence of 5 percent water and ether extracts increase fresh weight over control but effect of ether extract is more pronounced. However, increase in weight with 12 hrs pre-soaking treatment is more beneficial than 6 hrs treatment.

Statistical analysis of results shows that observed increases in 6 hrs treatment with 5 percent ether extract and 12 hrs treatment with 5 percent water and ether extracts are significant.

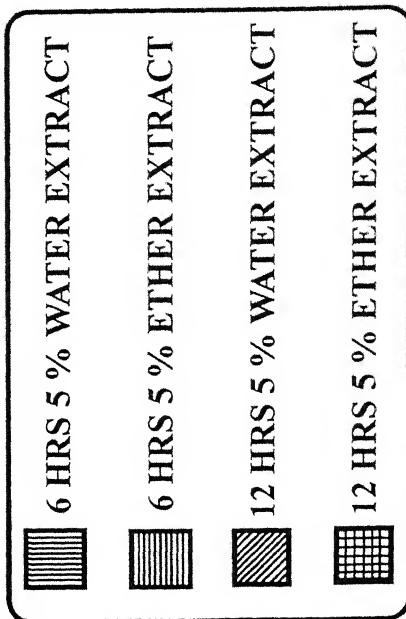
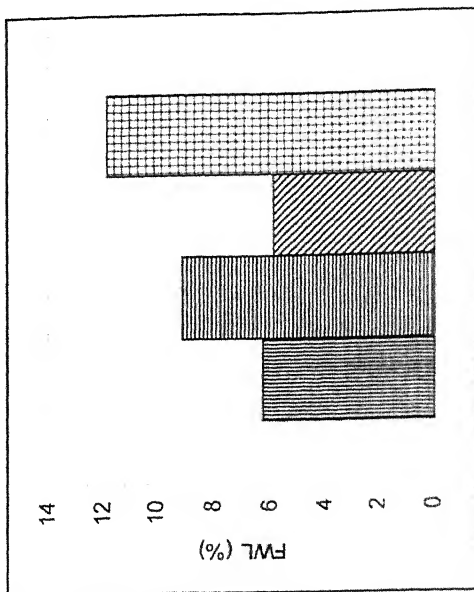
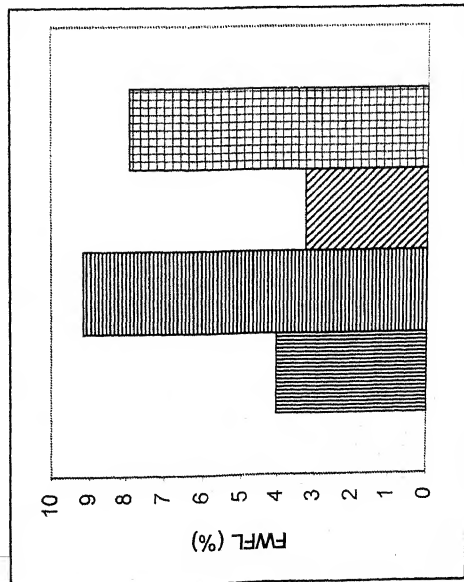
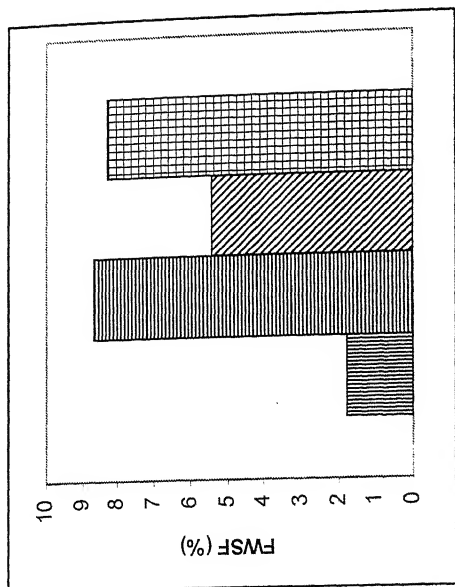
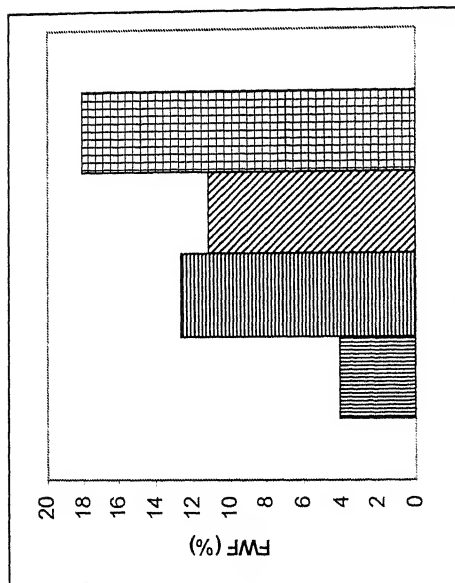
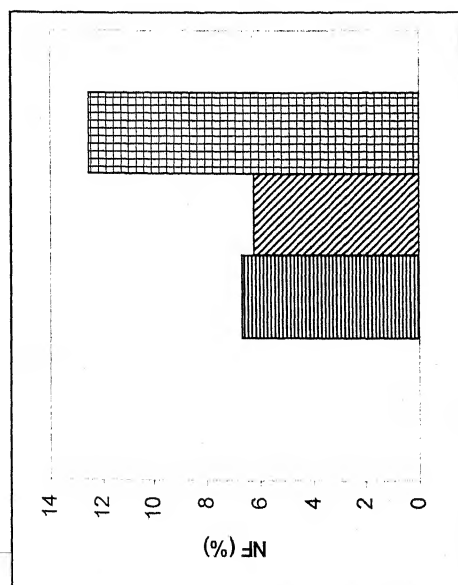
Effect on Fresh Weight of Single Fruit with Leafy Coverings:

An examination of Table-12 and Graph-12A, 12B show that treatments with 5 percent water and ether extracts for 6 and 12 hrs exercise an increase in weight of single fruit.

GRAPH-12A EFFECT OF PRE-SOAKING SEED TREATMENT ON YIELD OF MAIZE (AZAD UTTAM) PLANTS.

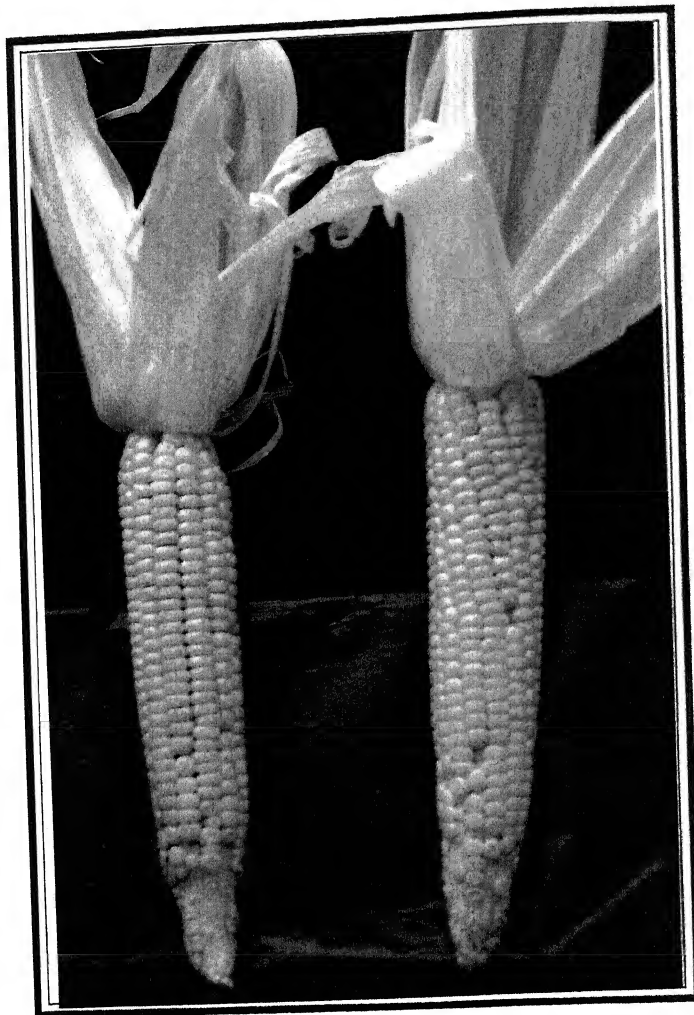


GRAPH-12B EFFECT OF PRE-SOAKING SEED TREATMENT ON YIELD OF MAIZE (AZAD UTTAM) PLANT.



PERCENTAGE INCREASE

PHOTO - 9: SHOWING EFFECT OF 12 HRS. PRE-SOAKING SEED
TREATMENT WITH *Spirodella polyrhiza* EXTRACT ON
YIELD OF MAIZE (AZAD UTTAM)



Control

5%ETHER WATER-EXTRACT

6 as well as 12 hrs are significant at 5 percent error probability.

INFLUENCE OF DRY MATTER PRODUCTION AND YIELD :

Effect on Dry Weight of Vegetative Foliage :

Results given in Table-13 and Graph-13A, 13B suggest an increase with both 5 percent water and ether extracts. The effect of 12 hrs treatment is more pronounced.

Statistical analysis of data shows observed increase with 5 percent ether extract and 6 hrs treatment is statistically significant at 5 percent error probability.

Effect on Dry Weight of Male Inflorescence :

A persual of Table-13 and Graph-13A, 13B on dry weight of male inflorescence show that both 5 percent water and ether extracts and treatments with 6 and 12 hrs mark an increase in dry matter. However, 12 hrs pre-soaking treatment with 5 percent ether extract is maximum effective.

Results were statistically analysed and the observed increase have been found to be insignificant at 5 percent error probability.

**GRAPH NO.-13: EFFECT OF PRE-SOAKING SEED TREATMENT ON
DRY MATTER PRODUCTION AND YIELD OF MAIZE
(AZAD UTTAM) PLANTS.**

DWVF : Dry weight of vegetative foliage

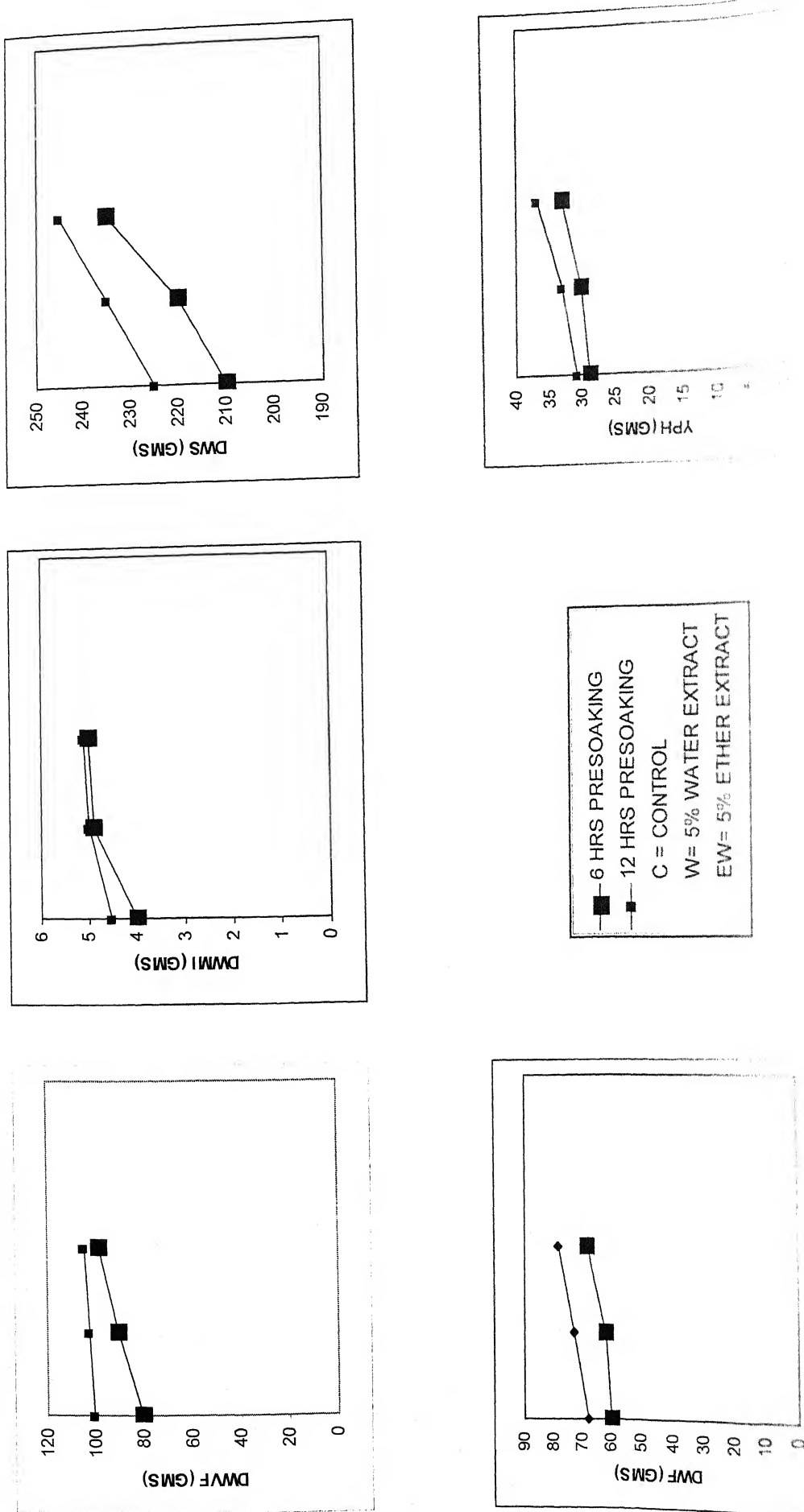
DWMI : Dry weight of male inflorescence

DWS : Dry weight of seed

DWF : Dry weight of fruits

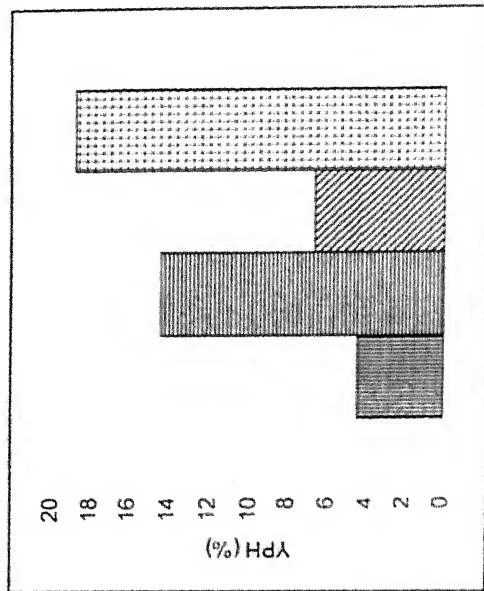
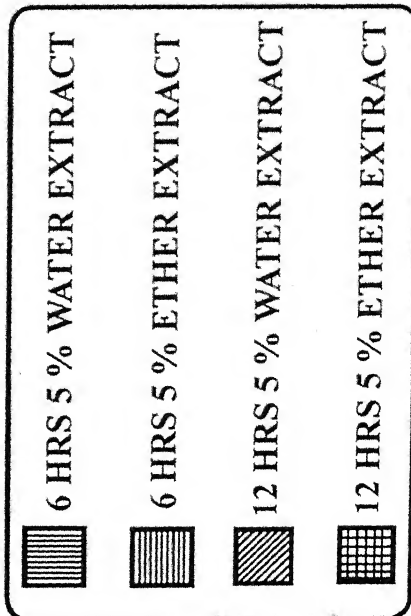
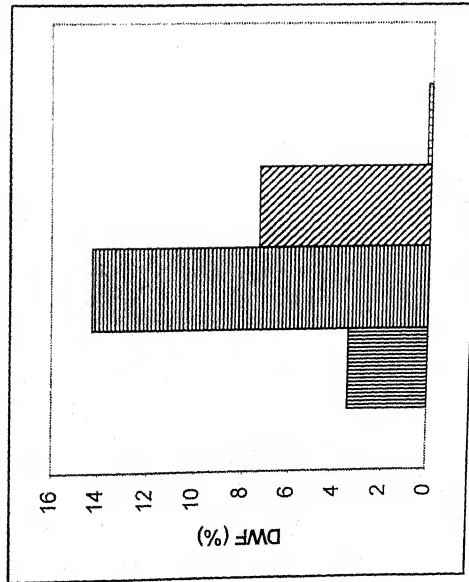
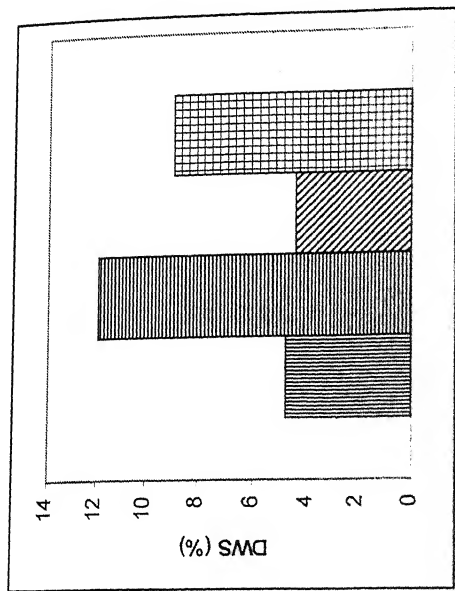
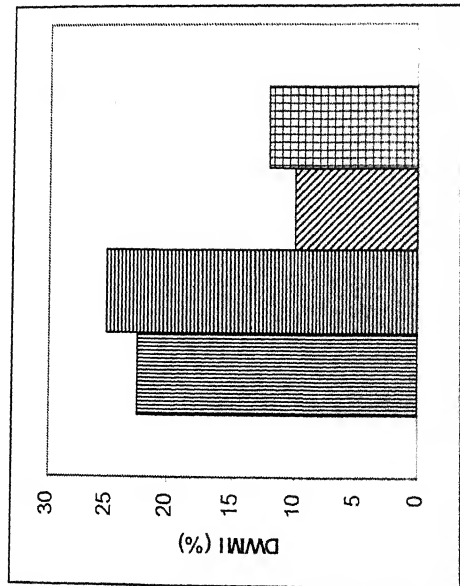
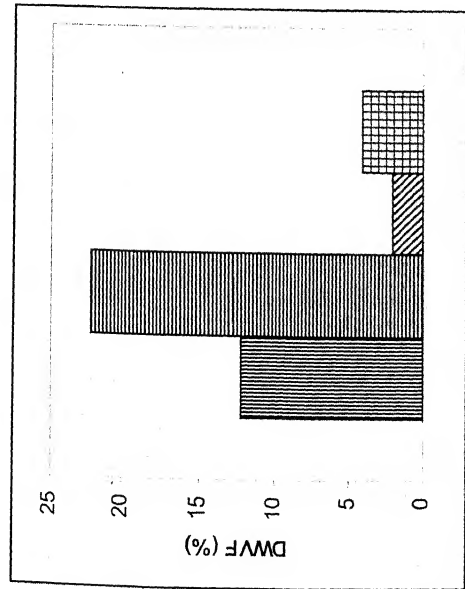
YPH : Yield per hectare

GRAPH-13A EFFECT OF PRE-SOAKING SEED TREATMENT ON DRY MATTER PRODUCTION & YIELD OF MAIZE (AZAD UTTAM) PLANT.



GRAPH-13B

EFFECT OF PRE-SOAKING SEED TREATMENT ON DRY MATTER PRODUCTION & YIELD OF MAIZE (AZAD UTTAM) PLANT.



PERCENTAGE INCREASE

Effect on Dry Weight of 1000 Seeds :

Observations recorded in Table-13 and Graph-13A, 13B show that weight of 1000 seeds is increased to the maximum extent with 5 percent ether extract and 12 hrs treatment. However, both extracts and soaking periods are beneficial in increasing dry weight of seeds.

Statistical analysis of result shows that observed increase with both kinds of extracts and soaking periods are significant at 5 percent error probability.

Effect on Dry Weight of Fruits Per Plant :

An examination of Table-13 and Graph-13A, 13B show that dry weight of fruits produced per plant increase significantly with 6 and 12 hrs pre-soaking seed treatments with 5 percent water and ether extracts. Effect of ether extract and 12 hrs treatment is comparatively more pronounced over water extract and 6 hrs treatment.

Statistical analysis of data shows that observed effects in 6 hrs treatment with 5 percent ether extract and 12 hrs treatment with 5 percent water and ether extracts are significant at 5 percent error probability.

Effect on Yield Per Hectare :

Results on yield of maize per hectare were calculated on the basis of yield obtained in experimental plots. The data given in Table-13 and Graph-13A, 13B show *S. polyrhiza* extracts exercise stimulation in yield with either 6 or 12 hrs treatments with 5 percent water or ether extracts. Influence of 12 hrs treatment and ether extract is better. Maximum yield is witnessed under 12 hrs treatment with 5 percent ether extract.

Results were statistically analysed following analysis of variance method and observed increases in 6 hrs treatment with 5 percent water extract and 12 hrs treatment with 5 percent water and ether extracts are found to be significant at 5 percent error probability.

INFLUENCE ON MATURATION OF FRUITS :

Effect on Fruit Maturation Period :

Observations given in Table-14 and Graph-14A, 14B on period of maturation required in treatments show that fruits mature earlier in treatments with 5 percent water and ether extracts. The effect of ether extract is more marked than water extracts. Results show that 6 and 12 hrs pre-soaking seed treatments have similar effects.

TABLE - 14: EFFECT OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON MATURATION OF FRUITS OF MAIZE (AZAD UTTAM) (AVERAGE OF 50 REPLICATES)

PRE-SOAKING PERIOD OF SEEDS	FRUIT MATURATION PERIOD IN DAYS			TREND OF FRUIT SETTING IN DAYS		
	C	5% W	5% EW	C	5% W	5% EW
6 hrs	22	21	20	52	50	48
12 hrs	22	21	20	50	50	48

C.D. = 2.87

C.D. = 0

6 hrs treatment
Diff. C-5% W = 2
Diff. C-5%EW = 4

Statistical
Analysis

6 hrs treatment
Diff. C-5% W = 1
Diff. C-5%EW = 2

12 hrs treatment
Diff. C-5% W = 0
Diff. C-5%EW = 2

12 hrs treatment
Diff. C-5% W = 1
Diff. C-5%EW = 2

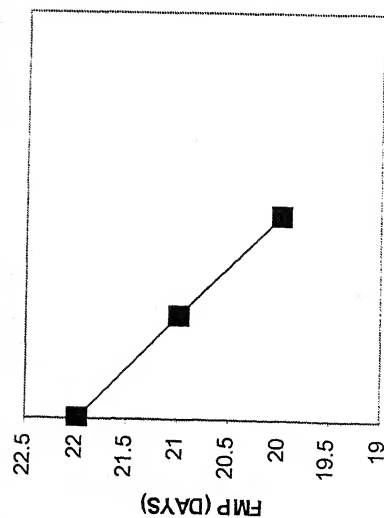
ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

***GRAPH NO.-14: EFFECT OF PRE-SOAKING SEED TREATMENT ON
MATURATION OF FRUITS OF MAIZE (AZAD
UTTAM) PLANTS.***

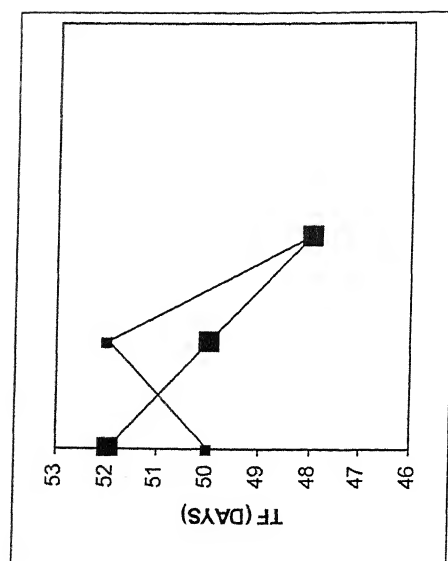
FMP : Fruit maturation period

TF : Trend of fruit setting

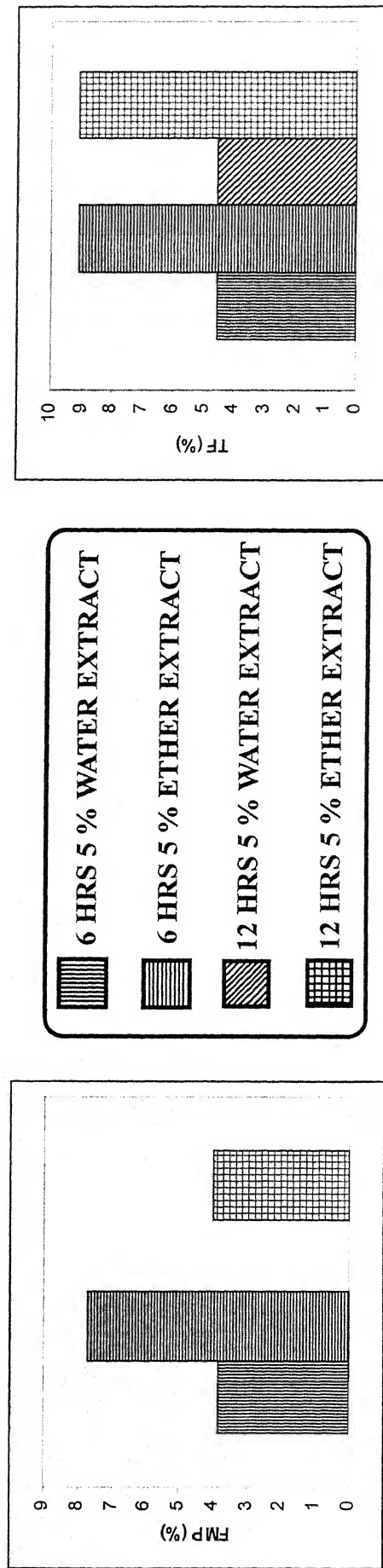
GRAPH-14A EFFECT OF PRE-SOAKING SEED TREATMENT ON MATURATION OF FRUITS OF MAIZE (AZAD UTTAM).



■ 6 HRS PRESOAKING
 ■ 12 HRS PRESOAKING
 C = CONTROL
 W = 5% WATER EXTRACT
 EW = 5% ETHER EXTRACT



GRAPH-14B EFFECT OF PRE-SOAKING SEED TREATMENT ON MATURATION OF FRUITS OF MAIZE
(AZADUTTAM) PLANT.



PERCENTAGE INCREASE

Statistical analysis of results shows that observed early maturation is significant at 5 percent error probability.

Effect on Trend of Fruit Setting :

A perusal of Table-14 and Graph-14A, 14B with reference to fruit setting show that fruits are set earlier in 6 and 12 hrs treatments with 5 percent water and ether extracts. Time required for setting of fruits in 5 percent ether extract (6 and 12 hrs treatment) and 5 percent water extract (12 hrs) treatment is shortest and identical.

Statistical analysis of data shows observed increase with 5 percent ether extract at 6 hrs treatment is statistically significant at 5 percent error probability.

RESPONSE ON MAIZE VARIETY R-49 :

INFLUENCE OF 6 HRS PRE-SOKING SEED TREATMENT ON VEGETATIVE GROWTH AND DEVELOPMENT :

Effect on Height of Plants :

Results on influence of 6 hrs pre-soaking seed treatment with 1 percent water and ether extract of *S. polyrhiza* are given in Table 15 and Graph-15A, 15B. An examination of data shows that both 1 percent water and ether extract promote height of plants over control but comparatively 1 percent ether extract is more beneficial. The beneficial influence of treatments is maintained throughout the duration of crop.

The data has been statistically analysed following analysis of variance method. Observed increase with 1 percent ether extract is significant at 5 percent error probability.

Effect on Number of Leaves :

Observations given in Table-15 and Graph-15A, 15B are indicative of increasing number of leaves from the beginning of experiment and the beneficial effect is maintained during subsequent observations. It has been observed that 1 percent ether extract is more effective than 1 percent water extract.

The data has been statistically analysed and observed increases with 1 percent water and ether extracts are

TABLE-15:

EFFECT OF 6 HRS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON GROWTH AND DEVELOPMENT OF MATURE MAIZE (R-49) PLANTS (AVERAGE OF 50 REPLICATES)

AGE OF PLANTS	HEIGHT OF PLANTS IN CM			NUMBER OF LEAVES PER PLANT			LENGTH OF LEAF IN CM			BREADTH OF LEAVES IN CM		
	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW
15 days	11.80	12.00	12.50	7.00	7.00	7.8	36.00	38.3	39.8	3.1	3.4	3.6
30 days	33.10	42.00	50.5	10.00	10.50	11.4	67.00	72.1	79.6	4.1	5.5	6.7
45 days	82.00	93.00	129.5	11.00	12.00	13.1	69.9	81.7	89.8	5.7	7.1	8.8

Difference calculated at 45 days

C.D. = 28.56
Diff. 1% W-C = 11
Diff 1% EW-C = 47.5

C.D. = 0.77
Diff. 1% W-C = 1.00
Diff 1% EW-C = 2.1

C.D. = 9.35
Diff. 1% W-C = 11.8
Diff 1% EW-C = 19.9

C.D. = 1.57
Diff. 1% W-C = 1.4
Diff 1% EW-C = 3.1

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

***GRAPH NO.-15: EFFECT OF 6 HRS. TREATMENT ON MATURE
PLANT GROWTH OF MAIZE (R-49).***

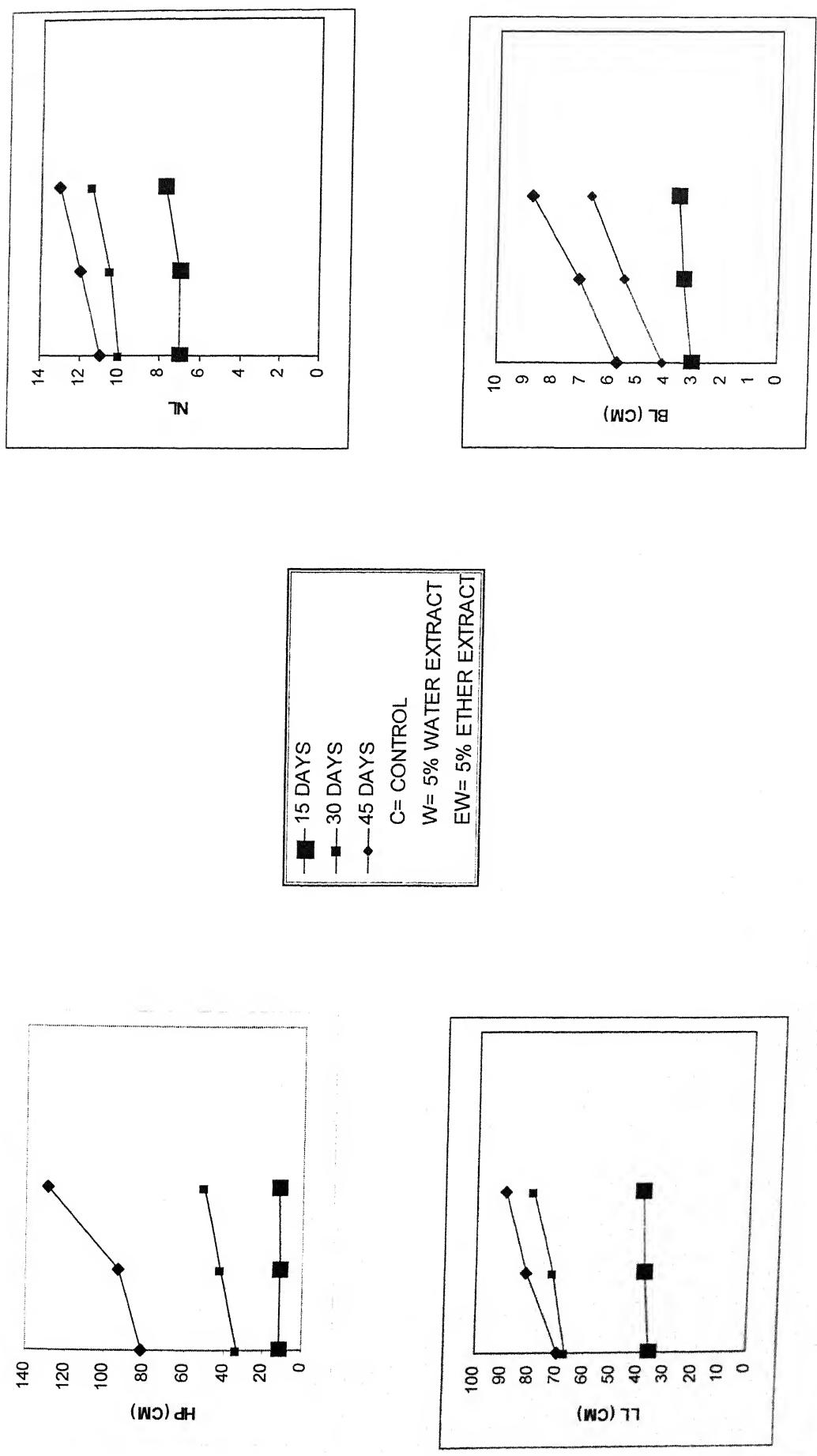
HP : Height of plant

NL : Number of leaf

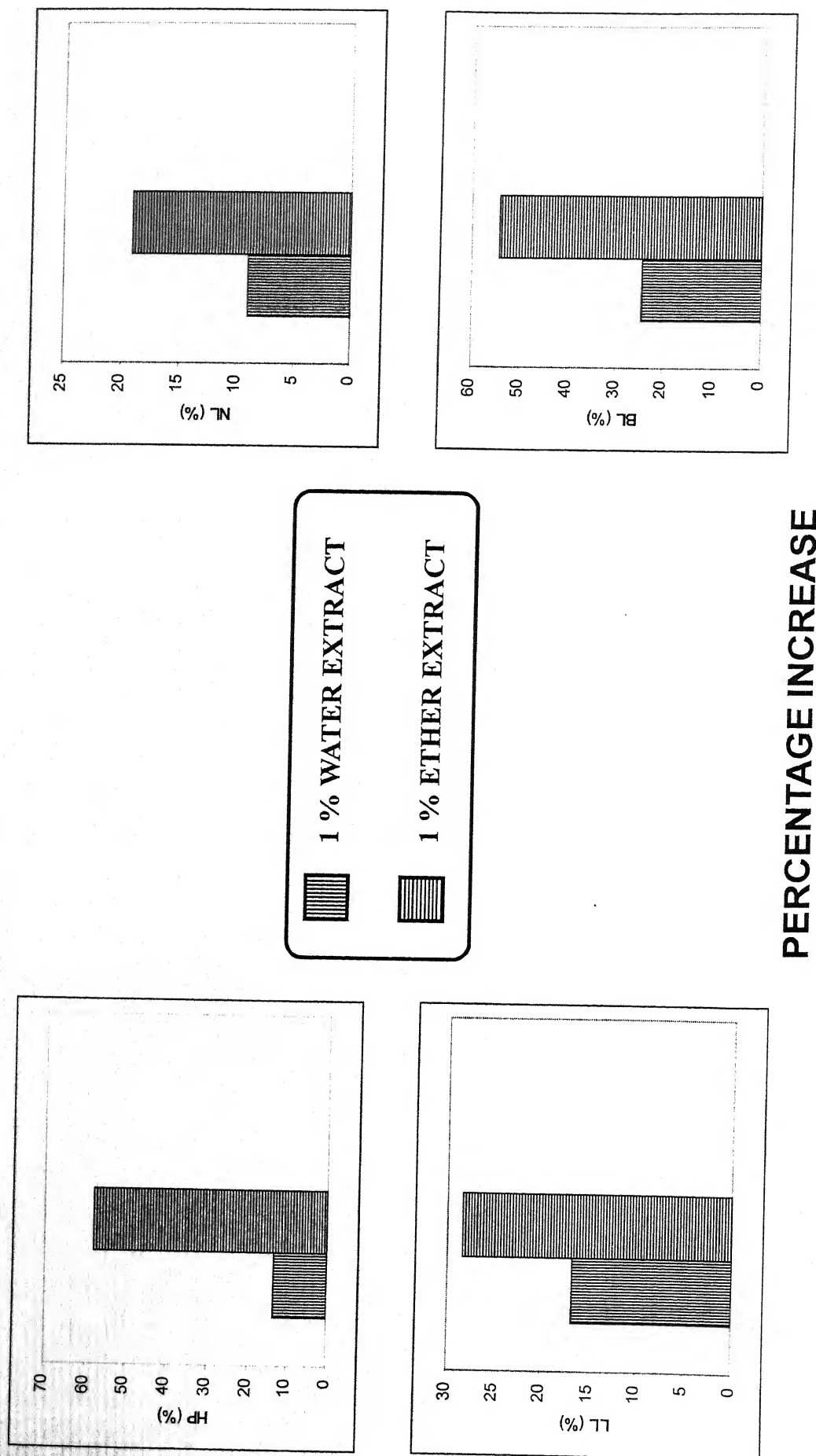
LL : Length of leaf

BL : Breadth of leaf

GRAPH-15A EFFECT OF 6 HRS TREATMENT ON MATURE PLANT GROWTH OF MAIZE (R-49).



GRAPH-15B EFFECT OF 6 HRS TREATMENT ON MATURE PLANT GROWTH OF MAIZE (R-49).



PERCENTAGE INCREASE

significant at 5 percent error probability.

Effect on Length of Leaf :

A perusal of Table-15 and Graph-15A, 15B show that length of leaves enlarges with 1 percent water and 1 percent ether extracts. A sustained beneficial effect on length of leaves has been observed throughout the duration of the crop. The effect of ether extract is comparatively more pronounced than water extract.

Statistical analysis of results shows that observed increases with 1 percent water and ether extracts are statistically significant after 45 days of sowing at 5 percent error probability.

Effect on Breadth of Leaves :

Observations on the effect of *S. polyrhiza* extracts on breadth of leaves are given in Table-15 and Graph-15A, 15B. The data shows an overall increase in breadth of leaves in treatments with 1 percent water and ether extracts. The beneficial effect is maintained throughout the duration of crop. However, effect of 1 percent ether extract is more pronounced than water extract.

The data has been statistically analysed following analysis of variance method and effects of 1 percent water and ether

extracts are found to be significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING SEED TREATMENT ON VEGETATIVE GROWTH AND DEVELOPMENT :

Effect on Height of Plants :

Results on influence of 12 hrs pre-soaking and treatment with 1 percent water and ether extract of *S. polyrhiza* are given in Table-16 and Graph-16A, 16B. An examination of data shows that both 1 percent water and ether extract promote height of plants over control but comparatively ether extract is more beneficial. The beneficial influence of treatments is maintained throughout the duration of crop.

Statistical analysis of data shows that increase in height of plants with 1 percent ether extract is significant at 5 percent error probability.

Effect on Number of Leaves :

Observation given in Table-16 and Graph-16A, 16B are indicative of increasing number of leaves from the beginning of experiment and the beneficial effect is maintained during subsequent observations. It has been observed that 1 percent ether extract is more effective than 1 percent water extract.

TABLE- 16 :

EFFECT OF 12 HRS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON GROWTH AND DEVELOPMENT OF MATURE MAIZE (R-49) PLANTS (AVERAGE OF 50 REPLICATES)

AGE OF PLANTS	HEIGHT OF PLANTS IN CM			NUMBER OF LEAVES PER PLANT			LENGTH OF LEAVES IN CM			BREADTH OF LEAVES IN CM		
	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW
15 days	12.0	13.5	14.0	8.1	9.2	9.6	39.0	39.6	41.0	3.0	3.5	4.0
30 days	50.0	55.1	60.50	11.0	12.2	13.4	80.0	82.0	84.1	6.1	7.4	7.9
45 days	139.1	145.4	150.1	12.3	13.4	13.5	81.1	82.0	86.1	8.0	8.4	8.1

Difference calculated

C.D. = 5.77
 Diff. 1% W-C = 6.3
 Diff 1% EW-C = 11

C.D. = 0.78

Diff. 1% W-C = 1.1
 Diff 1% EW-C = 1.2

C.D. = 2.04

Diff. 1% W-C = 0.90
 Diff 1% EW-C = 5.00

C.D. = 1.01

Diff. 1% W-C = 0.40
 Diff 1% EW-C = 0.10

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

***GRAPH NO.-16: EFFECT OF 12 HRS. TREATMENT ON MATURE
PLANT GROWTH OF MAIZE (R-49).***

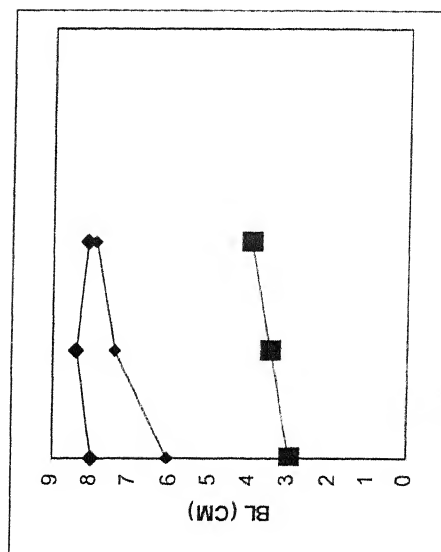
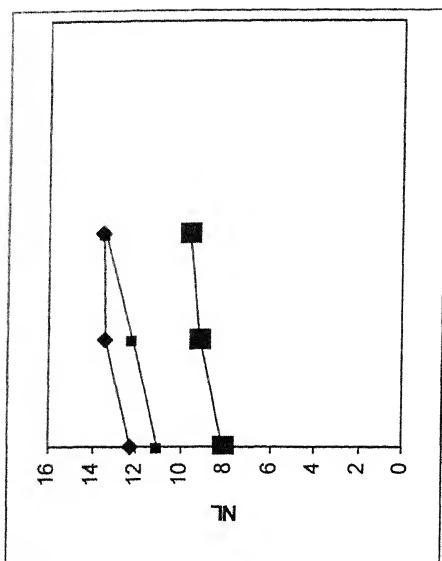
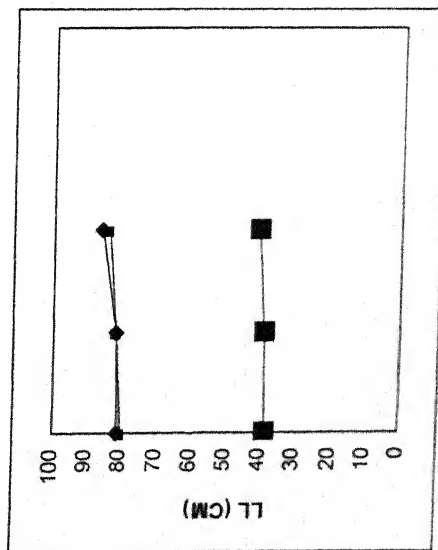
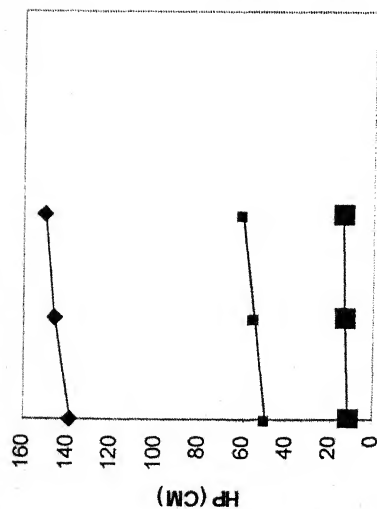
HP : Height of plant

NL : Number of leaf

LL : Length of leaf

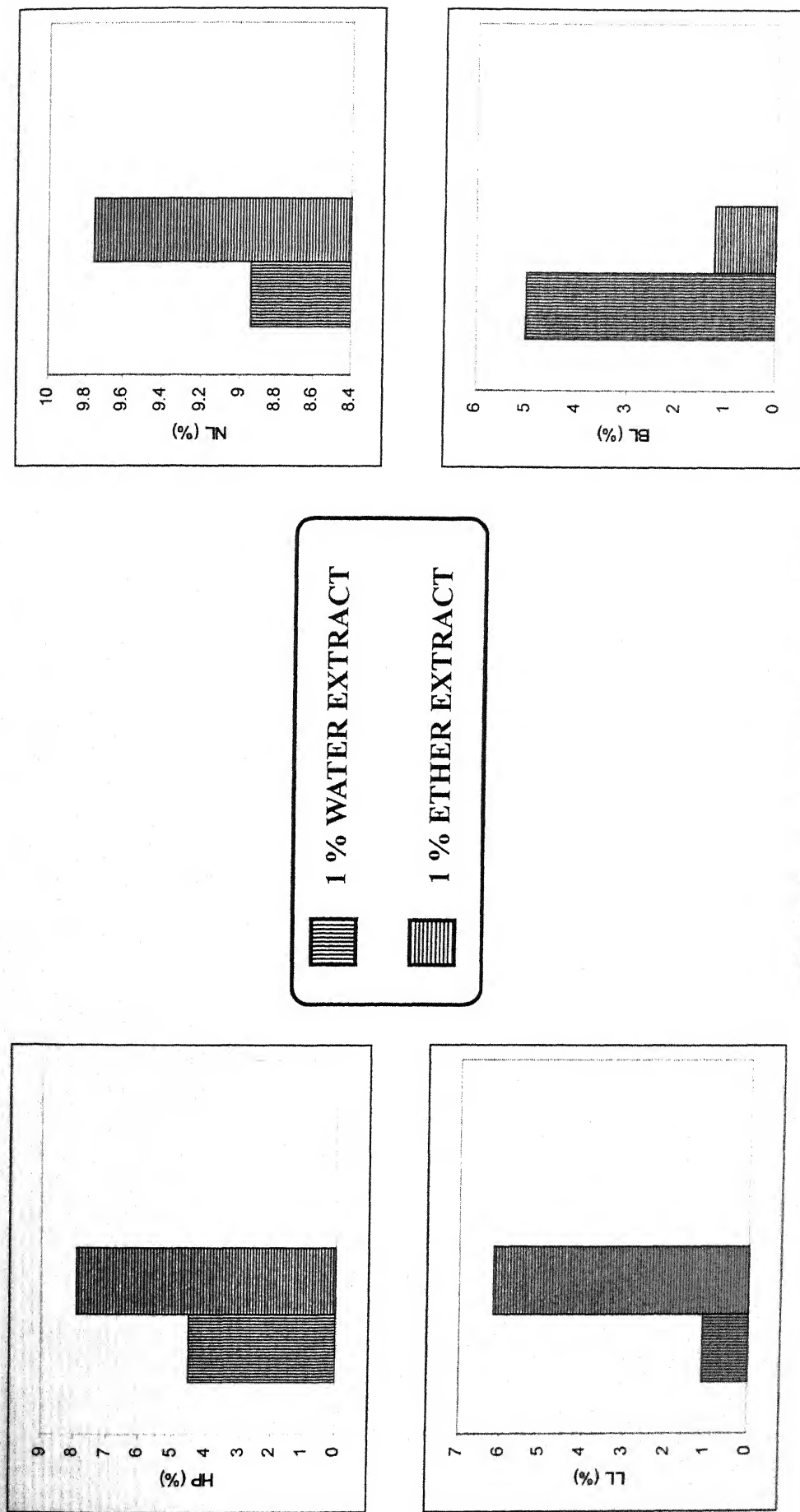
BL : Breadth of leaf

GRAPH-16A EFFECT OF 12 HRS TREATMENT ON MATURE PLANT GROWTH OF MAIZE (R-49).



■ 15 DAYS
 ■ 30 DAYS
 ◆ 45 DAYS
 C= CONTROL
 W= 5% WATER EXTRACT
 EW= 5% ETHER EXTRACT

GRAPH-16B **EFFECT OF 12 HRS TREATMENT ON MATURE PLANT GROWTH OF MAIZE (R-49).**



PERCENTAGE INCREASE

Statistical analysis of data shows that increase in number of leaves with 1 percent ether extract is significant at 5 percent error probability.

Effect on Length of Leaf :

A perusal of Table-16 and Graph-16A, 16B show that length of leaves enlarges with 1 percent water and 1 percent ether extracts. A sustained beneficial effect on length of leaves has been observed throughout the duration of the crop. The effect of ether extract is comparatively more pronounced than water extract.

Results were statistically analysed and observed increases in length of leaves with 1 percent water and ether extracts have been found to be significant at 5 percent error probability.

Effect on Breadth of Leaves :

Observations on the effect of *S. polyrhiza* extracts on breadth of leaves are given in Table-16 and Graph-16A, 16B. The data shows an overall increase in breadth of leaves in treatments with 1 percent water and ether extracts. The beneficial effect is maintained throughout the duration of crop. However, effect of 1 percent ether extract is more pronounced than water extracts.

The data was statistically analysed following analysis of variance method and influence on breadth of leaves is significant at 5 percent error probability.

INFLUENCE OF FRESH WEIGHTS OF FOLIAGE AND MALE INFLORESCENCE, NUMBER OF BRANCHES, AND FRUITS :

Effect on Fresh Vegetative Foliage Weight :

Results given in Table-17 and Graph-17A, 17B on weight of fresh vegetative foliage show that influence of 1 percent water and ether extracts increase fresh weight over control but effect of ether extract is more pronounced. However, increase in weight with 12 hrs pre-soaking treatment is more beneficial than 6 hrs.

Analysis of statistical results show that observed increases with 6 and 12 hrs treatments and 1 percent ether extract are significant at 5 percent error probability.

Effect on Fresh Weight of Male Inflorescence :

A perusal of Table-17 and Graph-17A, 17B are suggestive of the fact that treatment with 1 percent ether extract for 12 hrs is maximum in effectiveness. However, both 6 and 12 hrs treatment with 1 percent water and ether extracts are beneficial towards increase in fresh weight of male inflorescence.

TABLE-17 : EFFECT OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON FRESH WEIGHT OF FOLIAGE AND MALE INFLORESCENCE, NUMBER OF BRANCHES AND FRUITS OF MAIZE (R-49) PLANTS (AVERAGE OF 50 REPLICATES)

PRESOAK- ING PERIOD OF SEED	FRESH VEGETATIVE FOLIAGE WEIGHT PER PLANT IN GMS			FRESH WEIGHT OF MALE INFLORESCENCE PER PLANT IN GMS			NUMBER OF FLORAL BRANCHES PER MALE INFLO- RESCENCE			NUMBER OF FRUITS PER PLANT		
	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW
6 hrs	195.0	265.0	346.0	6.0	6.8	9.1	16.0	18.0	18.1	2.0	2.8	2.9
12 hrs	270.0	278.0	354.0	9.1	9.5	10.5	17.0	19.0	21.0	2.2	2.9	3.0

C.D. = 92.72

6 hrs treatment :

1% W-C = 70

1% EW-C = 151

Statistical

Analysis

C.D. = 2.21

6 hrs treatment :

1% W-C = 0.8

1% EW-C = 3.1

C.D. = 12.73

6 hrs treatment :

1% W-C = 2.0

1% EW-C = 2.1

C.D. = 0.143

6 hrs treatment :

1% W-C = 0.80

1% EW-C = 0.10

12 hrs treatment :

1% W-C = 8

1% EW-C = 84

12 hrs treatment :

1% W-C = 0.4

1% EW-C = 1.4

12 hrs treatment :

1% W-C = 2

1% EW-C = 4

12 hrs treatment :

1% W-C = 0.7

1% EW-C = 0.8

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

**GRAPH NO.-17: EFFECT OF PRE-SOAKING SEED TREATMENT ON
VEGETATIVE PRODUCTION AND YIELD OF MAIZE
(R-49) PLANTS.**

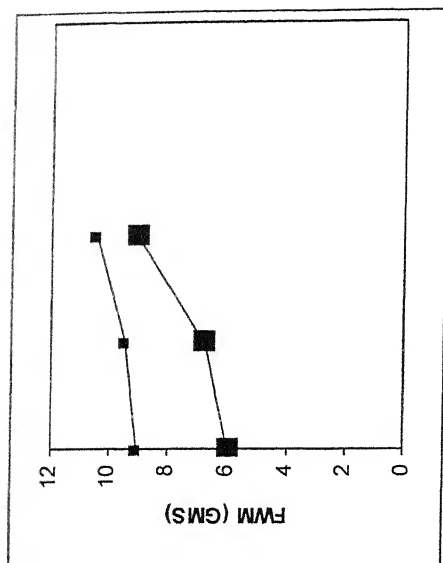
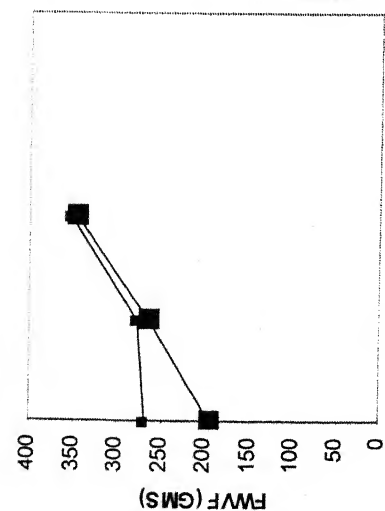
FWVF : Fresh vegetative foliage weight

FWMI : Fresh weight of male inflorescence

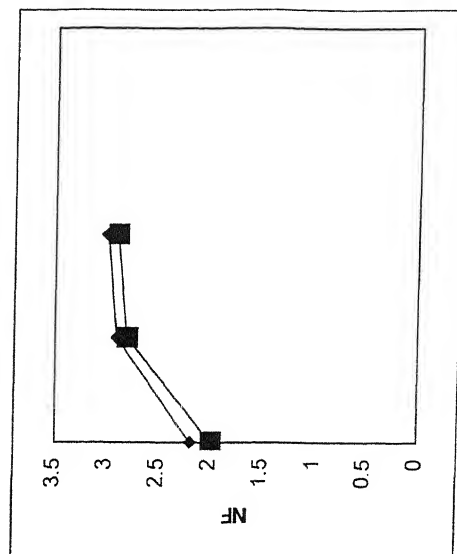
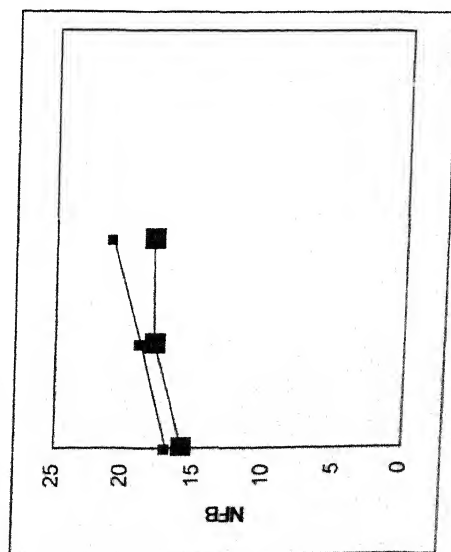
NFB : Number of floral branches per male inflorescence

NF : Number of fruits

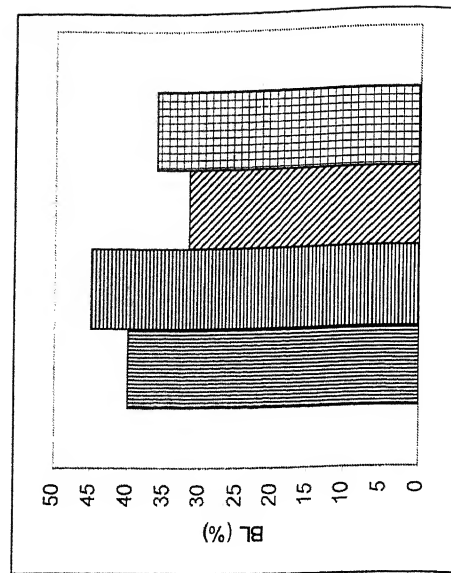
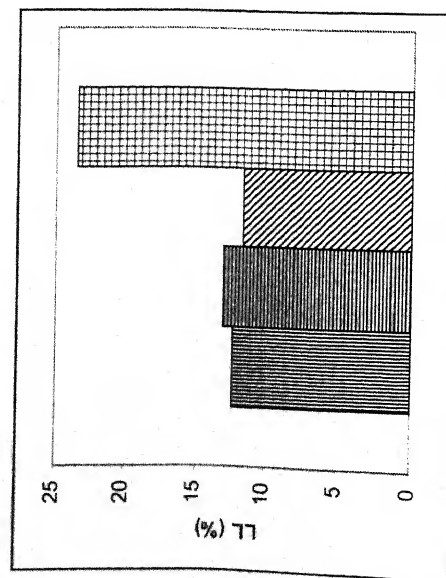
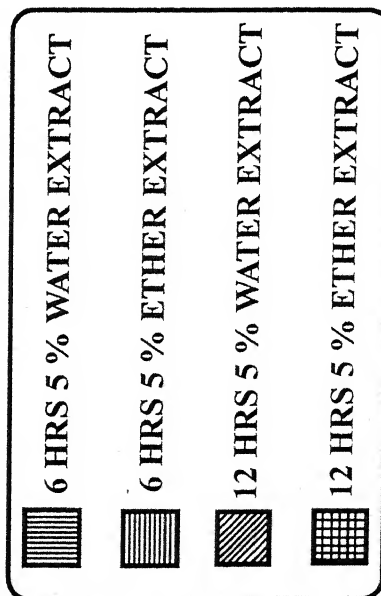
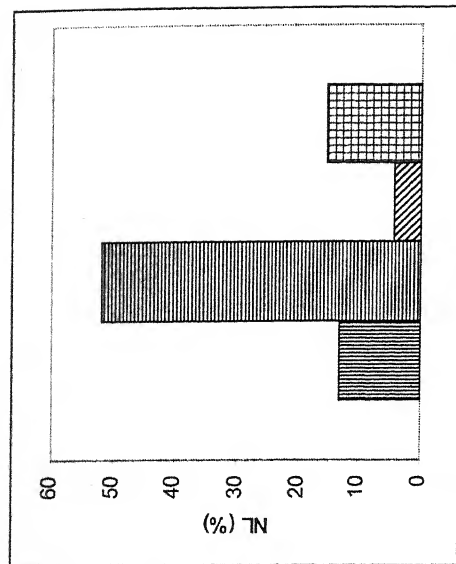
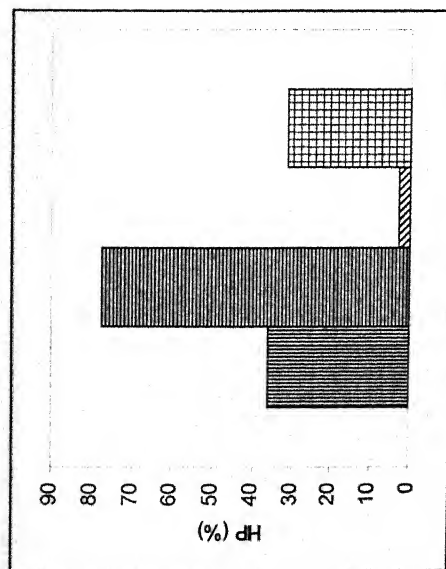
GRAPH-17A EFFECT OF PRE-SOAKING SEED TREATMENT ON VEGETATIVE PRODUCTION & YIELD OF MAIZE (R-49) PLANTS.



■ 6 HRS PRESOAKING
 ■ 12 HRS PRESOAKING
 C = CONTROL
 W = 5% WATER EXTRACT
 EW = 5% ETHER EXTRACT



GRAPH-17B EFFECT OF PRE-SOAKING SEED TREATMENT ON VEGETATIVE PRODUCTION AND YIELD OF MAIZE (R-49) PLANTS.



PERCENTAGE INCREASE

Statistical analysis of data shows that observed increase in fresh weight of male inflorescence with 6 hrs and 1 percent ether extract is significant at 5 percent error probability.

Effect on Number of Floral Branches in Inflorescence :

Results given in Table-17 and Graph-17A, 17B show that there is a marked influence of treatment. However, 12 hrs treatment is more effective. Treatment with 12 hrs at 1 percent ether extract is maximum effective.

Statistical analysis of results shows that effect with 12 hrs, 1 percent water and ether extracts is significant at 5 percent error probability.

Effect on Number of Fruits Per Plant :

A perusal of Table-17 and Graph-17A, 17B show that effect of 12 hrs treatment is more pronounced than 6 hrs treatment. However, 1 percent ether extract and 12 hrs treatment is maximum in effectiveness.

Results were statistically analysed following analysis of variance method and effects of both soaking periods of 6 and 12 hrs and 1 percent water and ether extracts are significant at 5 percent error probability.

INFLUENCE ON YIELD OF PLANTS :

Effect on Number Fruits :

A perusal of Table-18 and Graph-18A, 18B is indicative of the fact that 6 hrs and 12 hrs pre-soaking treatments impart an increase in number of fruits per plant. While 1 percent water and ether extract are both beneficial. Treatment with 1 percent ether extract at 12 hrs pre-soaking is maximum effective.

Statistical analysis of results shows that observed increases with both treatments and soaking periods are significant at 5 percent error probability.

Effect on Fresh Weight of Fruits :

Results given in Table-18 and Graph-18A, 18B on weight of fruits per plant show that influence of 1 percent water and ether extracts increase fresh weight over control but effect on ether extract is more pronounced. However, increase in weight with 12 hrs pre-soaking treatment is more beneficial than 6 hrs.

Statistical analysis of results shows that observed increases with both treatments and soaking periods are significant at 5 percent error probability.

TABLE - 18 :

EFFECT OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON YIELD OF MAIZE
(R-49) PLANTS (AVERAGE OF 50 REPLICATES)

PRE-SOAK- ING PERIOD OF SEEDS	NUMBER OF FRUITS PER PLANT			FRESH WEIGHT OF FRUIT PER PLANT IN GMS			FRESH WEIGHT OF SINGLE FRUIT WITH LEAFY COVER- INGS IN GMS			FRESH WEIGHT OF SINGLE FRUIT WITHOUT LEAFY COVERINGS IN GMS			FRESH WEIGHT OF LEAFY COVERINGS PER FRUIT IN GMS		
	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW
6 hrs	2.0	2.8	2.9	108.0	160.1	189.2	68.00	88.74	98.96	52.00	65.98	77.39	18.1	19.0	21.3
12 hrs	2.2	2.9	3.0	114.2	175.9	199.1	70.1	92.74	99.71	53.84	73.72	78.00	18.9	20.00	22.5
<div> <div>C.D. = 0.143</div> <div>C.D. = 12.03</div> <div>C.D. = 4.06</div> <div>C.D. = 9.47</div> <div>C.D. = 0.50</div> </div>															
Statistical Analysis	<u>6 hrs treatment</u>			<u>6 hrs treatment</u>			<u>6 hrs treatment</u>			<u>6 hrs treatment</u>			<u>6 hrs treatment</u>		
	Diff. 1%W -C = 0.8			Diff. 1%W -C = 52.1			Diff. 1%W-C = 20.74			Diff. 1%W-C = 13.98			Diff. 1%W-C = 0.9		
	Diff. 1%EW-C = 0.9			Diff. 1%EW-C = 81.2			Diff. 1%W-C = 30.96			Diff. 1%W-C = 25.39			Diff. 1%W-C = 3.2		
	<u>12 hrs treatment</u>			<u>12 hrs treatment</u>			<u>12 hrs treatment</u>			<u>12 hrs treatment</u>			<u>12 hrs treatment</u>		
	Diff. 1%W-C = 0.7			Diff. 1%EW-C = 61.7			Diff. 1%EW-C = 22.64			Diff. 1%EW-C = 19.88			Diff. 1%EW-C = 1.1		
	Diff. 1%EW-C = 0.8			Diff. 1%W-C = 84.9			Diff. 1%W-C = 29.61			Diff. 1%W-C = 24.16			Diff. 1%W-C = 3.6		

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

PHOTO -10: SHOWING EFFECT OF 6 HRS. PRE-SOAKING SEED
TREATMENT WITH *Spirodella polyrhiza* EXTRACT
ON YIELD OF MAIZE (R-49)



Control

1%ETHER WATER-EXTRACT

***GRAPH NO.-18: EFFECT OF PRE-SOAKING SEED TREATMENT ON
YIELD OF MAIZE (R-49) PLANTS.***

NF : Number of fruits

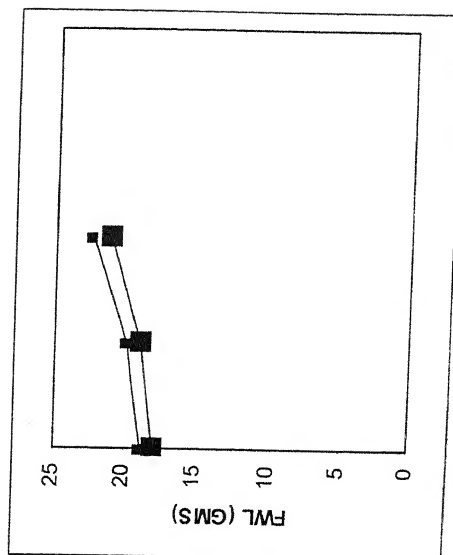
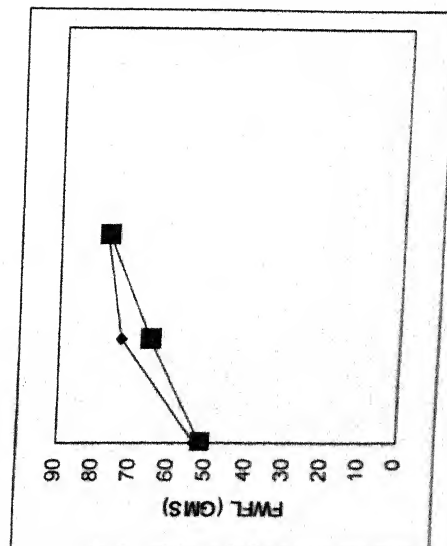
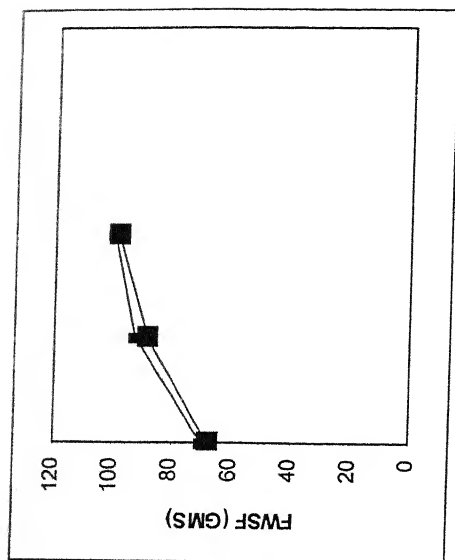
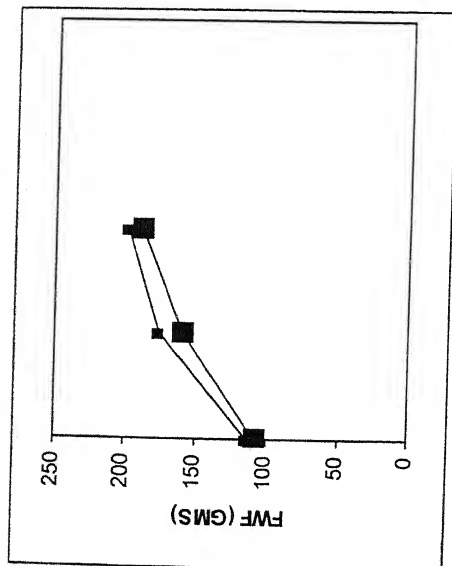
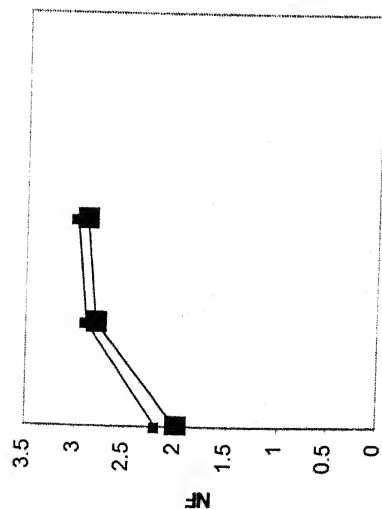
FWL : Fresh weight of fruits

FWSF : Fresh weight of single fruit with leafy coverings

FWFL : Fresh weight of single fruit without leafy covering

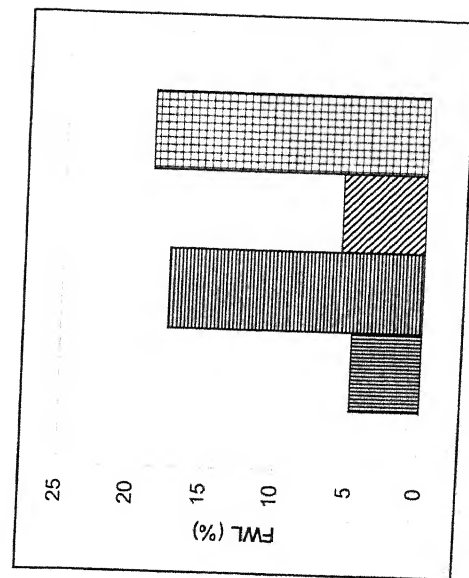
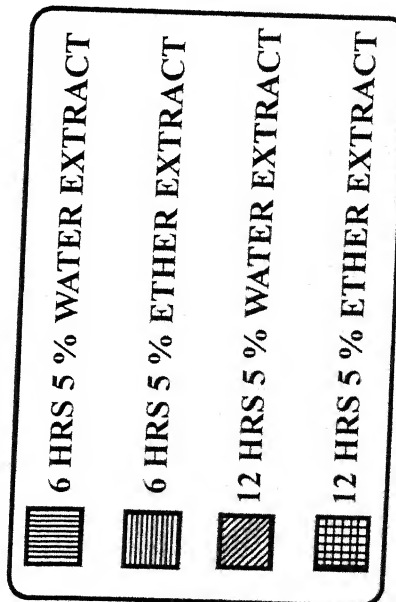
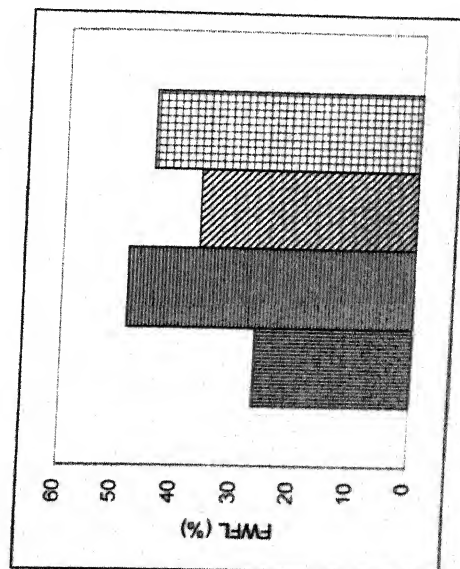
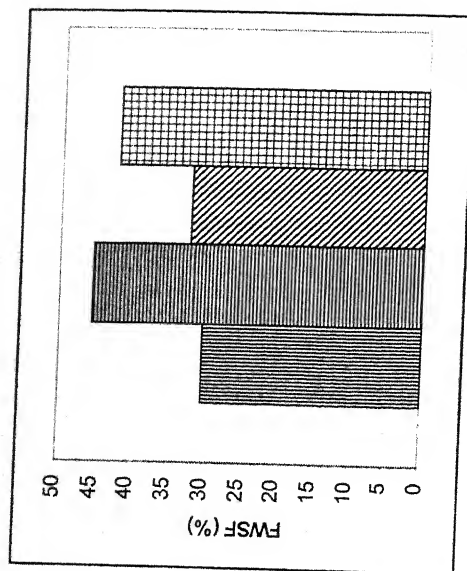
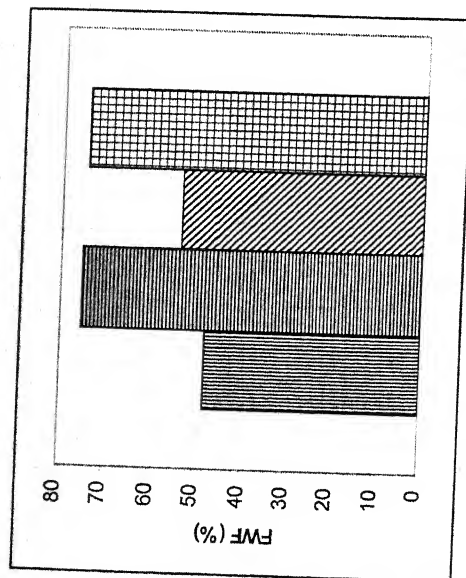
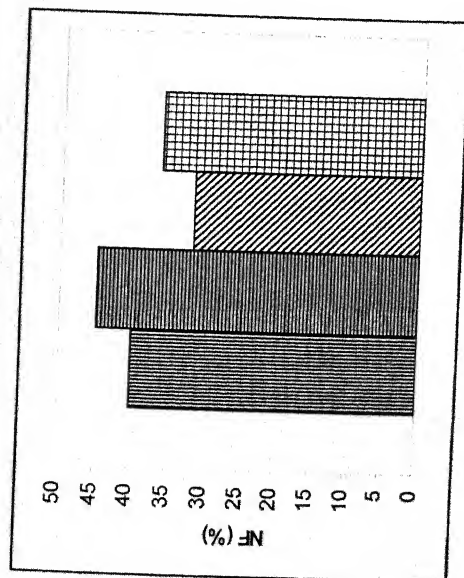
FWL : Fresh weight of leafy coverings

GRAPH-18A EFFECT OF PRE-SOAKING SEED TREATMENT ON YIELD OF MAIZE (R-49) PLANTS.



■ 6 HRS PRESOAKING
 ■ 12 HRS PRESOAKING
 C = CONTROL
 W= 5% WATER EXTRACT
 EW= 5% ETHER EXTRACT

GRAPH-18B EFFECT OF PRE-SOAKING SEED TREATMENT ON YIELD OF MAIZE (R-49) PLANTS.



PERCENTAGE INCREASE

Effect on Fresh Weight of Single Fruit with Leafy Coverings:

An examination of Table-18 and Graph-18A, 18B show that treatment with 1 percent water and ether extracts for 6 and 12 hrs exercise an increase in weight of single fruit. Ether extract at 12 hrs treatment is more effective. However, maximum increase in weight of fruit appeared with 1 percent ether extract and 12 hrs treatment.

Statistical analysis of results shows that observed increases with both treatments and soaking period are significant at 5 percent error probability.

Effect on Fresh Weight of Single Fruit Without Leafy Coverings:

Observations given in Table-18 and Graph-18A, 18B show that treatments with 1 percent water and ether extracts exercise beneficial effect and increase in weight of single fruit without leafy coverings. However, effect of 1 percent ether extract and 12 hrs pre-soaking treatment exercises maximum effect.

Statistical analysis of results shows that observed increases with both treatments and pre-soaking periods are significant at 5 percent error probability.

Effect on Fresh Weight of Leafy Coverings Per Fruit :

A perusal of Table-18 and Graph-18A, 18B show that effect of 12 hrs treatments are more pronounced than 6 hrs treatments. However, treatment for 12 hrs with 1 percent ether extract is maximum in effectiveness.

Statistical analysis of results shows that observed increase with both treatments and pre-soaking periods are significant at 5 percent error probability.

INFLUENCE ON DRY MATTER PRODUCTION AND YIELD :

Effect on Dry Weight of Vegetative Foliage :

Results given in Table-19 and Graph-19A, 19B suggest an increase with both 1 percent water and ether extracts. The effect of 12 hrs treatment is more pronounced.

Statistical analysis of data shows observed increase with 1 percent ether extract and 6 hrs treatment is statistically significant at 5 percent error probability.

Effect on Dry Weight of Male Inflorescence :

A perusal of Table-19 and Graph-19A, 19B on dry weight of male inflorescence shows that both 1 percent water and ether extracts and treatments with 6 and 12 hrs mark an increase in dry matter. However, 12 hrs pre-soaking treatment

EFFECT OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON DRY MATTER PRODUCTION AND YIELD OF MAIZE (R-49) PLANTS (AVERAGE OF 50 REPLICATES)

	C.D. = 16.29		C.D. = 0.68		C.D. = 5.74		C.D. = 2.12		C.D. = 0.224	
Statistical Analysis	<u>6 hrs treatment</u>		<u>6 hrs treatment</u>		<u>6 hrs treatment</u>		<u>6 hrs treatment</u>		<u>6 hrs treatment</u>	
	Diff. 1% W-C =	9	Diff. 1% W-C =	0.4	Diff. 1% W-C =	17	Diff. 1% W-C =	24.33	Diff. 1% W-C =	12.58
	Diff. 1% EW-C =	21	Diff. 1% EW-C =	0.9	Diff. 1% EW-C =	27	Diff. 1% EW-C =	41	Diff. 1% EW-C =	21.68
	<u>12 hrs treatment</u>		<u>12 hrs treatment</u>		<u>12 hrs treatment</u>		<u>12 hrs treatment</u>		<u>12 hrs treatment</u>	
	Diff. 1% W-C =	4	Diff. 1% W-C =	0.9	Diff. 1% W-C =	21	Diff. 1% W-C =	23.4	Diff. 1% W-C =	12.5
	Diff. 1% EW-C =	8	Diff. 1% EW-C =	0.96	Diff. 1% EW-C =	31	Diff. 1% EW-C =	39.3	Diff. 1% EW-C =	21.5

ABBREVIATIONS USED: C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference

PHOTO -11: SHOWING EFFECT OF 12 HRS. PRE-SOAKING SEED
TREATMENT WITH *Spirodella polyrhiza* EXTRACT
ON YIELD OF MAIZE (R-49)



Control

1%ETHER WATER-EXTRACT

**GRAPH NO.-19: EFFECT OF PRE-SOAKING SEED TREATMENT ON
DRY MATTER PRODUCTION AND YIELD OF MAIZE
(R-49) PLANTS.**

DWVF : Dry weight of vegetative foliage

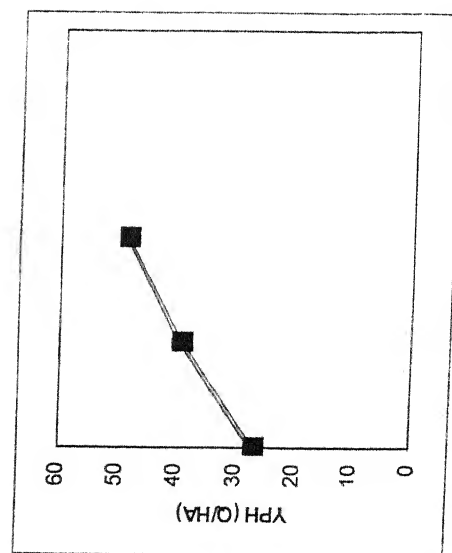
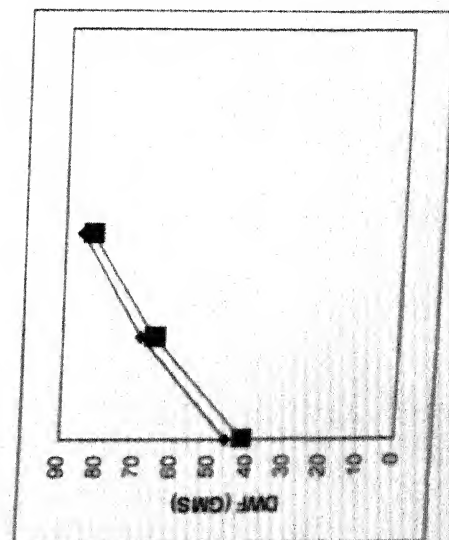
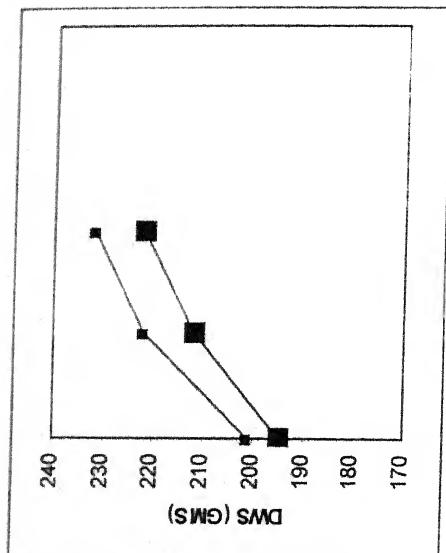
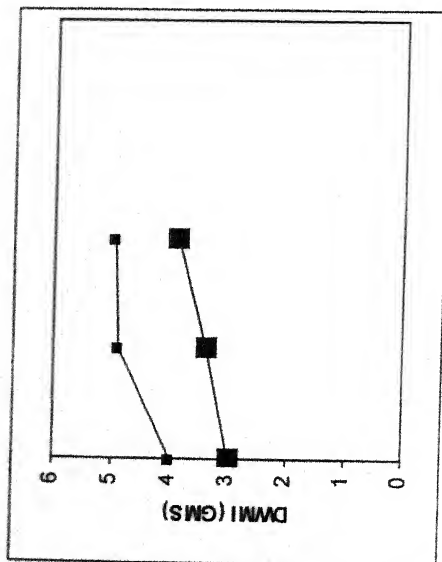
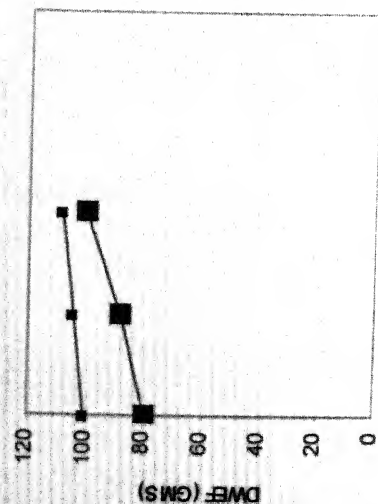
DWMI : Dry weight of male inflorescence

DWS : Dry weight of seed

DWF : Dry weight of fruits

YPH : Yield per hectare

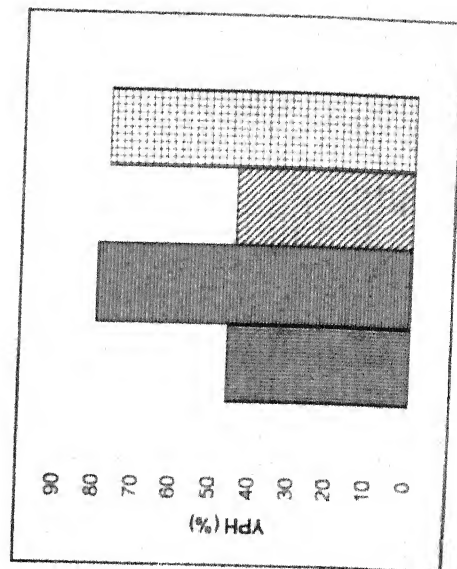
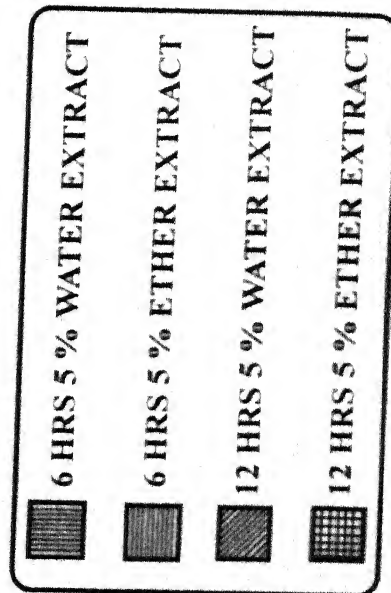
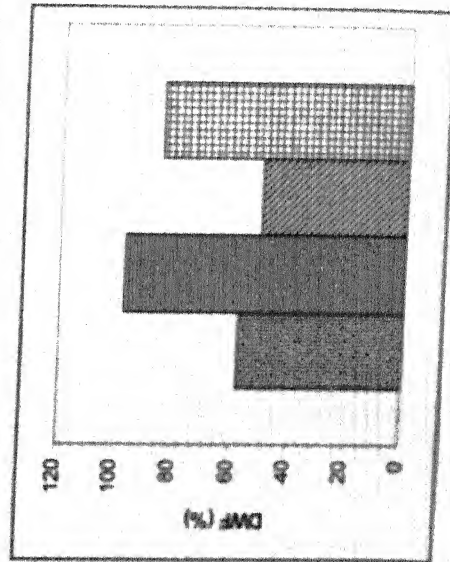
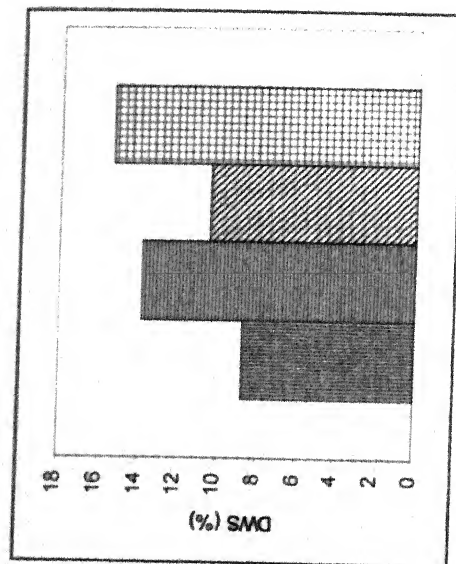
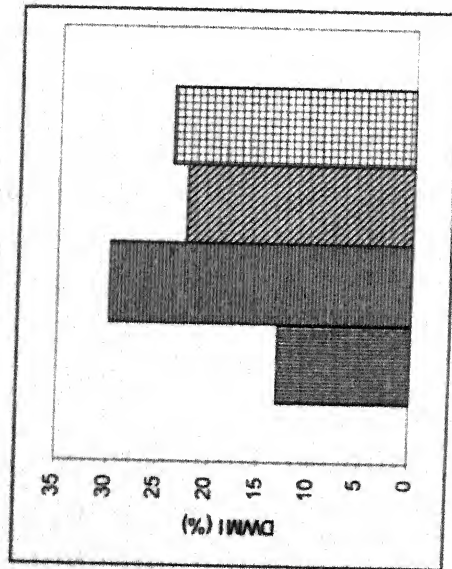
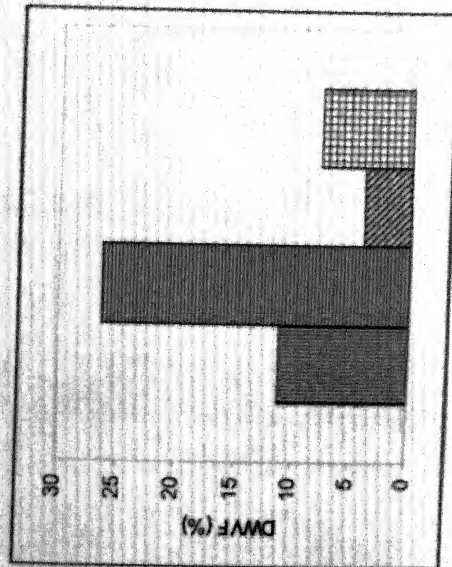
GRAPH-19A EFFECT OF PRE-SOAKING SEED TREATMENT OF DRY MATTER PRODUCTION & YIELD OF MAIZE (R-49) PLANT.



■ 6 HRS PRESOAKING
 ■ 12 HRS PRESOAKING
 C = CONTROL
 W= 5% WATER EXTRACT
 EW= 5% ETHER EXTRACT

GRAPH-19B

EFFECT OF PRE-SOAKING SEED TREATMENT OF DRY MATTER PRODUCTION AND YIELD OF MAIZE (R-49) PLANT.



PERCENTAGE INCREASE

with 1 percent ether extract is maximum effective.

Statistical analysis of data shows that observed effects with treatments are insignificant at 5 percent error probability.

Effect on Dry Weight of 1000 Seeds :

Observation recorded in Table-19 and Graph-19A, 19B show that weight of 1000 seeds is increased to the maximum extent with 1 percent ether extract and 12 hrs treatment. However, both extracts and soaking periods are beneficial in increasing dry weight of seeds.

A perusal of statistical analysis shows that observed increases in weight of 1000 seeds with 6 and 12 hrs treatment of 1 percent ether extract are significant at 5 percent error probability.

Effect on Dry Weight of Fruits Per Plant :

An examination of Table-19 and Graph-19A, 19B show that dry weight of fruits produced per plant increases significantly with 6 and 12 hrs pre-soaking seed treatments with 1 percent water and ether extracts. Effect of ether extract at 12 hrs treatment is comparatively more pronounced over water extract and 6 hrs treatment. Evidently, maximum increase has been observed under 12 hrs treatment with 1 percent ether extract.

TABLE - 20 : EFFECT OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON MATURATION OF FRUIT OF MAIZE (R-49) (AVERAGE OF 50 REPLICATES)

PRE-SOAKING PERIOD OF SEEDS	FRUIT MATURATION PERIOD IN DAYS			TREND OF FRUIT SETTING IN DAYS		
	C	1% W	1% EW	C	1% W	1% EW
6 hrs	21	20	18	56	55	52
12 hrs	21	20	19	48	47	46

C.D. = 1.43

6 hrs treatment

Diff C - 1% W = 1

Diff C - 1% EW = 3

C.D. = 2.87

6 hrs treatment

Diff C - 1% W = 1

Diff C - 1% EW = 4

Statistical Analysis

12 hrs treatment

Diff C - 1% W = 1

Diff C - 1% EW = 2

12 hrs treatment

Diff C - 1% W = 1

Diff C - 1% EW = 2

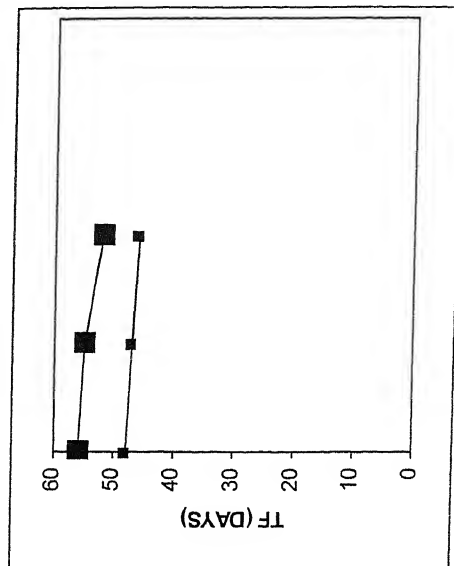
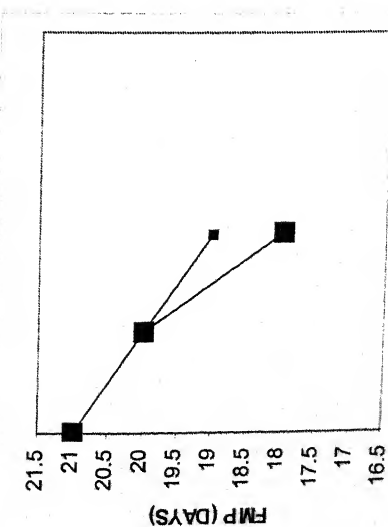
ABBREVIATIONS USED: C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

***GRAPH NO.-20: EFFECT OF PRE-SOAKING SEED TREATMENT ON
MATURATION OF FRUITS OF MAIZE (R-49)
PLANTS.***

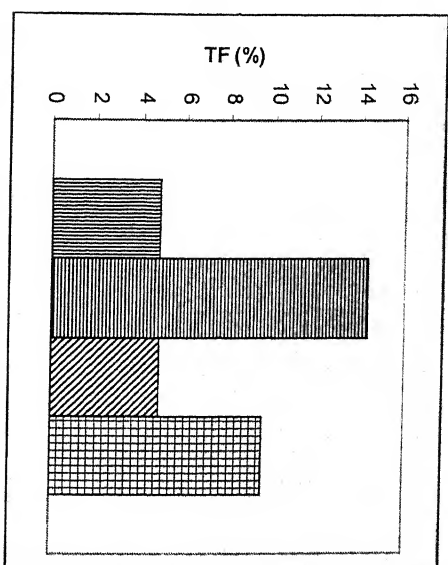
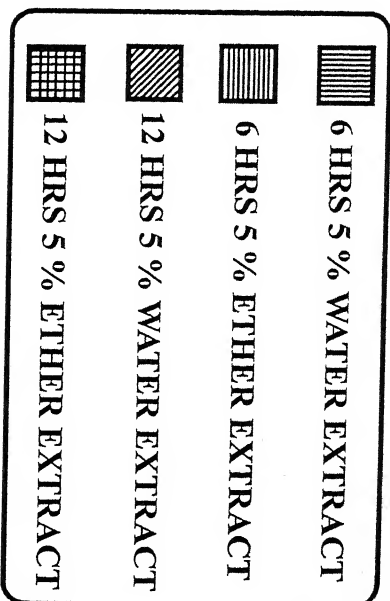
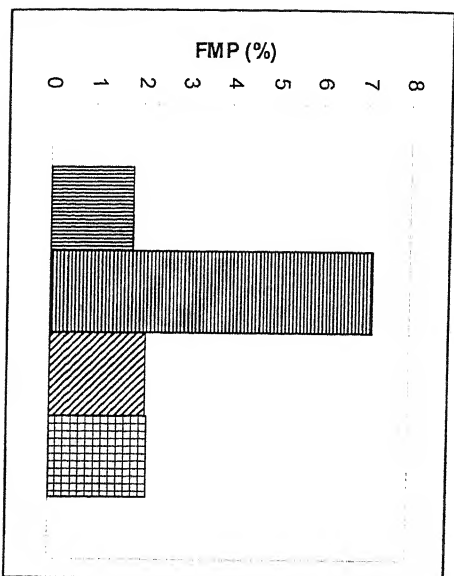
FMP : Fruit maturation period

TF : Trend of fruit setting

GRAPH-20A EFFECT OF PRE-SOAKING SEED TREATMENT ON MATURATION OF FRUITS OF MAIZE (R-49) PLANTS.



GRAPH-20B EFFECT OF PRE-SOAKING SEED TREATMENT ON MATURATION OF FRUITS OF MAIZE (R-49) PLANTS.



PERCENTAGE INCREASE

Statistical analysis of data shows that observed effects with both kinds of extracts and pre-soaking periods are found to be significant at 5 percent error probability.

Effect on Yield Per Hectare :

Results on yield of maize per hectare were calculated on the basis of yield obtained in experimental plots. The data given in Table-19 and Graph-19A, 19B show *S. polyrhiza* extracts exercise stimulation in yield with either 6 or 12 hrs treatment with 1 percent water or ether extracts. Influence of 12 hrs treatment in ether extract is better. Maximum yield is witnessed under 12 hrs treatment with 1 percent ether extract.

Results were statistically analysed following analysis of variance method and observed increases with both kinds of extracts and pre-soaking periods are found to be significant at 5 percent error probability.

INFLUENCE ON MATURATION OF FRUITS :

Effect on Fruit Maturation Period :

Observations given in Table-20 and Graph-20A, 20B on period of fruit maturation required in treatments show that fruits mature earlier in treatments with 1 percent water and ether extracts. The effect of ether extract is more marked than

water extracts. Results show that 6 and 12 pre-soaking seed treatments have similar effect.

Statistical analysis of data is suggestive that observed increase with 1 percent ether extract applied for 6 and 12 are significant at 5 percent error probability.

Effect on Trend of Fruit Setting :

Observation given in Table-20 and Graph-20A, 20B show that trend of fruit setting is accomplished earlier than control in treatments with 1 percent water and ether extracts applied as pre-soaking seed treatment for 6 hrs. However, treatment of 12 hrs were found to be ineffective.

Statistical analysis of results shows that observed increase is insignificant at 5 percent error probability.

CHAPTER 3

STUDIES ON EFFECTS OF *Spirodella polyrhiza* EXTRACTS ON QUALITY OF MAIZE YIELD.

STUDIES ON EFFECT OF *Spirodella polyrhiza* EXTRACTS ON QUALITY OF MAIZE YIELD

RESPONSE OF MAIZE VARIETY (AZAD UTTAM) :

Observation on response of maize (Azad Uttam) plants raised after pre-soaking seed treatment with *Spirodella polyrhiza* extracts on total nitrogen, protein, potassium and phosphorus contents in seeds were made. Treatment with 5 percent water and 5 percent ether extract for 6, 12 and 24 hrs was given to the seeds of maize (Azad Uttam) prior to germination and sowing. Results of influence observed are described as below-

TOTAL NITROGEN CONTENTS OF SEEDS :

A perusal of results given in Table-21 and Graph-21A, 21B show that percentage of total nitrogen increases over control in 5 percent water and 5 percent ether extracts. However, the effect of later is more pronounced than that of former. A comparison of effect of 6, 12 and 24 hrs

TABLE- 21 :

EFFECT OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON QUALITY OF MAIZE (AZAD UTTAM) SEEDS (AVERAGE OF 50 REPLICATES)

PRE-SOAKING PERIOD OF SEEDS	PERCENTAGE OF NITROGEN			PERCENTAGE OF PROTEIN			PHOSPHORUS (Mg/100 gms)			POTASSIUM (Mg/100 gms)		
	C	5%W	5%EW	C	5%W	5%EW	C	5%W	5%EW	C	5%W	5%EW
6 hrs	1.7	1.8	1.89	10.62	11.25	11.81	300	307	320	251	265	280
12 hrs	1.8	1.90	2.00	11.25	11.87	12.5	304	309	335	254	270	285
24 hrs	1.9	1.9	2.21	11.87	11.87	13.81	306	310	342	258	272	290

C.D. = 0.14

6 hrs treatment :

Diff. 5%W-C = 0.1

Diff. 5%EW-C = 0.19

C.D. = 0.88

6 hrs treatment :

Diff. 5% W-C = 0.63

Diff 5% EW-C = 1.19

C.D. = 11.838

6 hrs treatment :

Diff. 5% W-C = 7

Diff. 5% EW-C = 20

C.D. = 2.389

6 hrs treatment :

Diff. 5%W-C = 14

Diff. 5% EW-C = 29

Statistical analysis

12 hrs treatment :

Diff. 5%W-C = 0.1

Diff. 5%EW-C = 0.2

12 hrs treatment :

Diff. 5% W-C = 0.62

Diff 5% EW-C = 1.25

12 hrs treatment :

Diff. 5% W-C = 5

Diff. 5% EW-C = 31

24 hrs treatment :

Diff. 5%W-C = 0

Diff. 5%EW-C = 0.31

24 hrs treatment :

Diff. 5% W-C = 0

Diff 5% EW-C = 1.94

24 hrs treatment :

Diff. 5% W-C = 4

Diff. 5% EW-C = 36

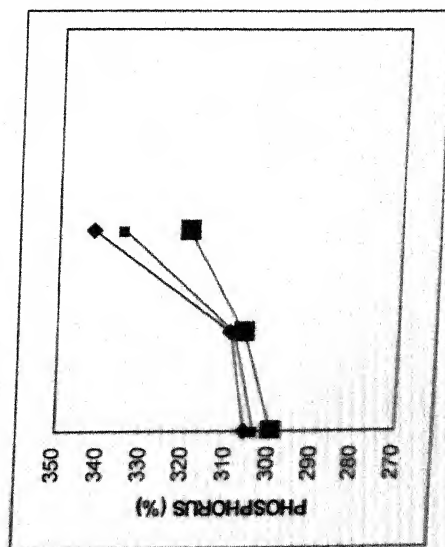
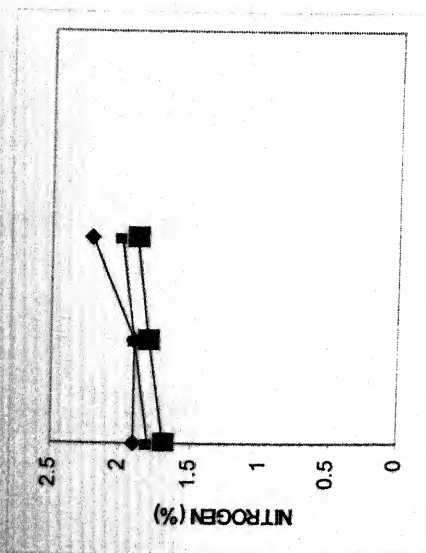
24 hrs treatment :

Diff. 5%W-C = 14

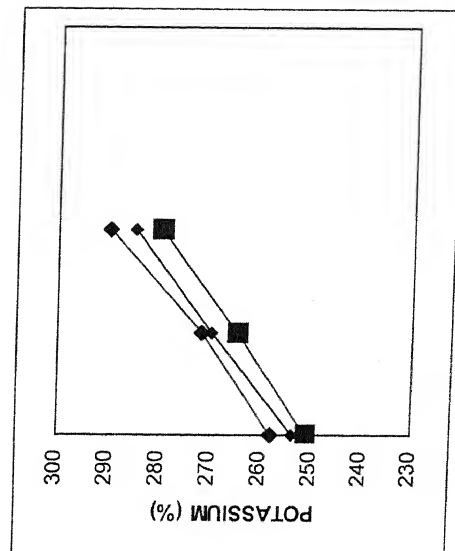
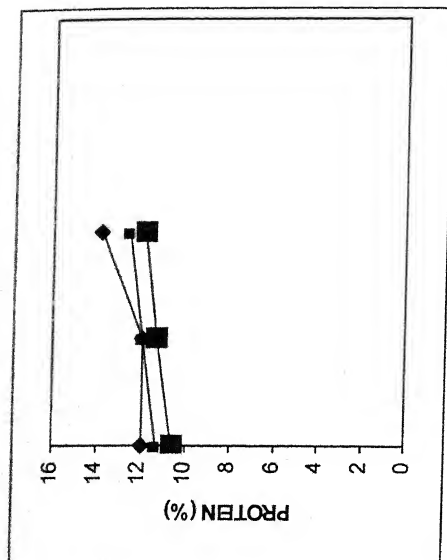
Diff. 5% EW-C = 32

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water, C.D. = Critical Difference.

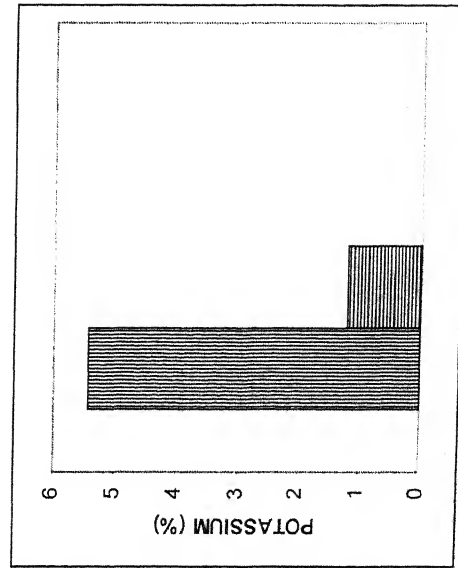
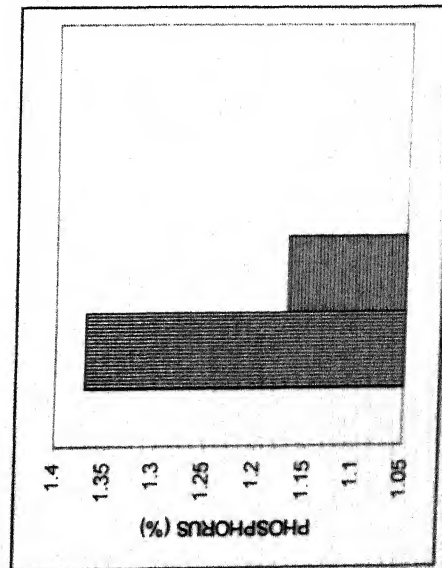
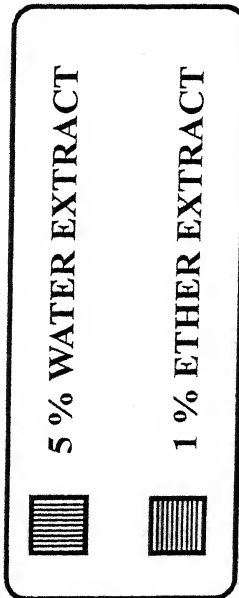
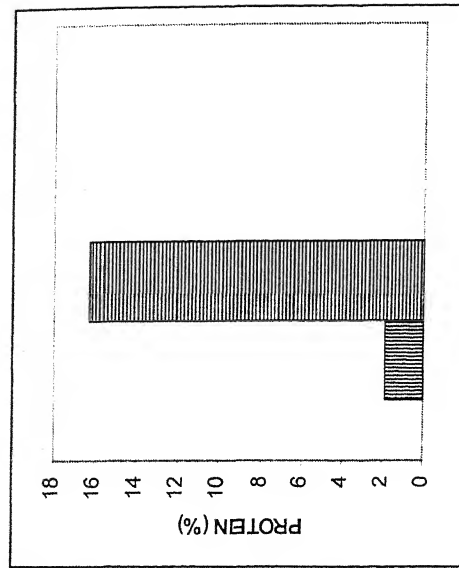
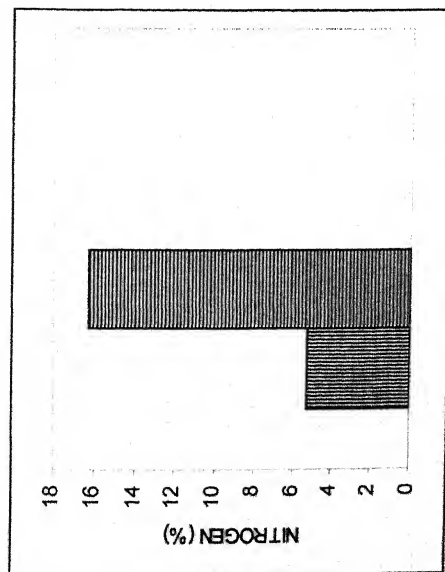
GRAPH-21A EFFECT OF PRE-SOAKING SEED TREATMENT ON PERCENTAGE OF NITROGEN, PROTEIN, PHOSPHORUS, POTASSIUM OF MAIZE (AZAD UTTAM).



■ 6 HRS PRESOAKING
 ◆ 12 HRS PRESOAKING
 ▲ 24 HRS PRESOAKING
 C= CONTROL
 W= 5% WATER EXTRACT
 EW= 5% ETHER EXTRACT



GRAPH-21B EFFECT OF PRE-SOAKING SEED TREATMENT ON PERCENTAGE OF NITROGEN, PROTEIN, PHOSPHORUS, POTASSIUM OF MAIZE (AZAD UTTAM).



PERCENTAGE INCREASE

treatments show that application of 24 hrs is more effective.

Results were statistically analysed following analysis of variance method and observed increases with 5 percent water and 5 percent ether extracts given for 6, 12 and 24 hrs are significant at 5 percent error probability.

TOTAL PROTEIN CONTENTS OF SEEDS :

Results given in Table-21 and Graph-21A, 21B exhibit that effect on total protein goes hand in hand with nitrogen content. 5 percent ether extract and 24 hrs treatments being more effective than 5 percent water extract and 24 hrs treatments. However, maximum increase in protein contents over control has been witnessed in treatments with 5 percent ether extract given as in 24 hrs pre-soaking seed treatments.

Statistical analysis of data shows that observed increases with 5 percent water and 5 percent ether extracts given for 6, 12 and 24 hrs are significant at 5 percent error probability.

PHOSPHORUS CONTENTS OF SEEDS :

A perusal of results given in Table-21 and Graph-21A, 21B show that total phosphorus contents of seeds (Mg./100 gms) increase over control in 5 percent water and 5 percent ether extracts. However, the effect of later is more pronounced than that of former. A comparison of effect of 6, 12 and 24 hrs treatment shows that application of 24 hrs is more effective.

Results were statistically analysed following analysis of variance method and observed increases with 5 percent water and 5 percent ether extracts given for 6, 12 and 24 hrs are significant at 5 percent error probability.

POTASSIUM CONTENTS OF SEEDS :

A perusal of results given in Table-21 and Graph-21A, 21B show that total potassium contents of seeds (Mg/100 gms) increase over control in 5 percent water and 5 percent ether extracts. However, the effect of later is more pronounced than that of former. A comparison of effect of 6, 12 and 24 hrs treatments shows that application of 24

hrs is more effective.

Results were statistically analysed following analysis of variance method and observed increases with 5 percent water and 5 percent ether extracts given for 6, 12 and 24 hrs are significant at 5 percent error probability.

RESPONSE OF MAIZE VARIETY (R-49) :

Observations on response of maize (R-49) plants raised after pre-soaking seed treatment with *Spirodella* *Polyrhiza* extracts on total nitrogen, protein, potassium, phosphorus treatment with 1 percent water and 1 percent ether extract for 6, 12 and 24 hrs was given to the seeds of maize (R-49) prior to germination and sowing. Results of influence observed are described below -

TOTAL NITROGEN CONTENTS OF SEEDS :

A perusal of results given in Table-22 and Graph-22A, 22B show that percentage of total nitrogen increases over control in 1 percent water and 1 percent ether extracts. However, the effect of later is more pronounced than that of former. A comparison of effect of 6, 12 and 24 hrs treatments shows that application of 24 hrs is more effective.

Results were statistically analysed following analysis of variance method and observed increases with 1

TABLE- 22 : EFFECT OF PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON QUALITY OF MAIZE (R-49) SEEDS. (AVERAGE OF 50 REPLICATES)

PRE-SOAKING PERIOD OF SEEDS	PERCENTAGE OF NITROGEN			PERCENTAGE OF PROTEIN			POTASSIUM (Mg/100 gms)			PHOSPHORUS (Mg/100 gms)		
	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW
6 hrs	1.7	1.85	1.90	10.62	11.56	11.87	248	261	275	297	303	318
12 hrs	1.76	1.95	2.00	11.00	12.18	12.5	250	264	281	299	305	332
24 hrs	1.85	1.98	2.25	11.56	12.37	14.06	254	270	287	301	308	341

C.D.= 0.16

6 hrs treatment :

Diff. 1%W-C = 0.15

Diff. 1%EW-C = 0.2

12 hrs treatment :

Diff. 1%W-C = 0.19

Diff. 1%EW-C = 0.24

24 hrs treatment :

Diff. 1%W-C = 0.13

Diff. 1%EW-C = 0.4

C.D. = 0.97

6 hrs treatment :

Diff. 1% W-C = 0.94

Diff 1% EW-C = 1.25

12 hrs treatment :

Diff. 1% W-C = 1.18

Diff 1% EW-C = 1.5

24 hrs treatment :

Diff. 1% W-C = 0.81

Diff 1% EW-C = 2.5

C.D. = 3.54

6 hrs treatment

Diff. 1% W-C = 13

Diff. 1%EW-C = 27

12 hrs treatment

Diff. 1% W-C = 14

Diff. 1%EW-C = 31

24 hrs treatment

Diff. 1% W-C = 16

Diff. 1%EW-C = 33

C.D.= 12.30

6 hrs treatment

Diff. 1%W -C = 6

Diff. 1% EW-C = 21

12 hrs treatment

Diff. 1% W-C = 6

Diff. 1% EW-C = 33

24 hrs treatment

Diff. 1% W-C = 7

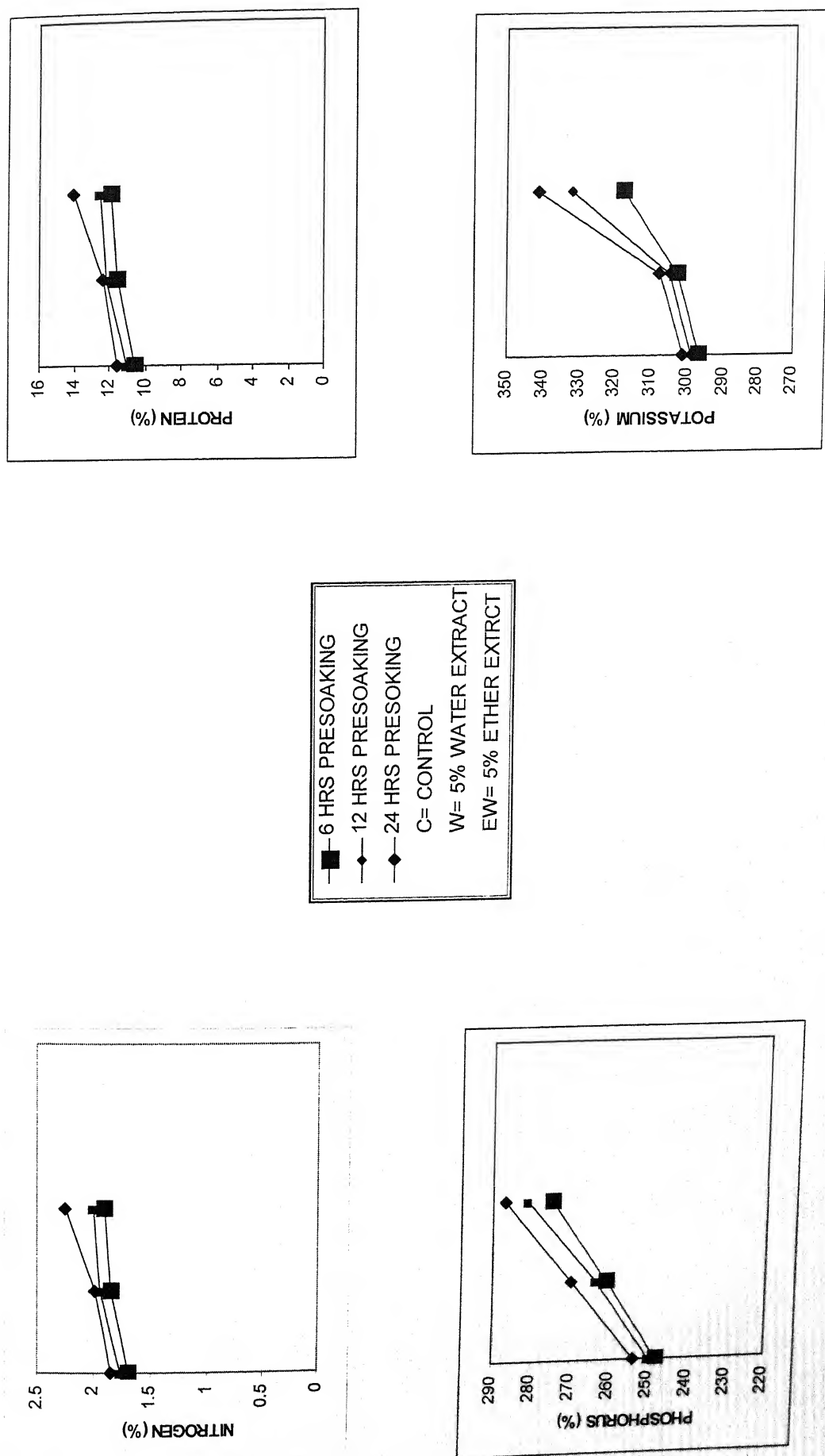
Diff. 1% EW-C = 40

Statistical analysis

Statistical analysis

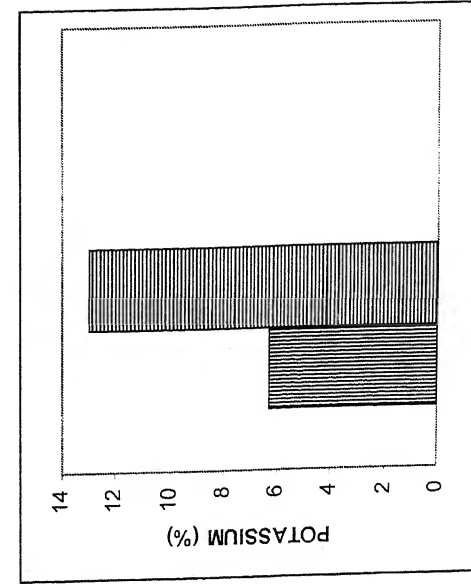
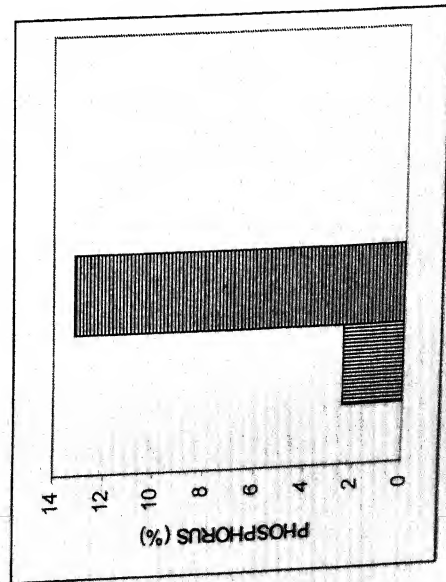
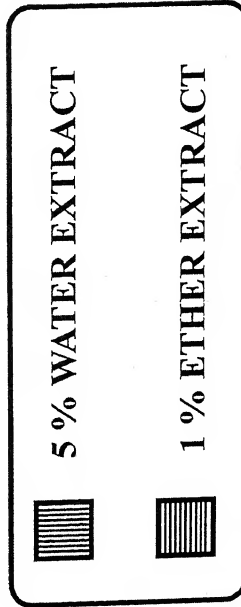
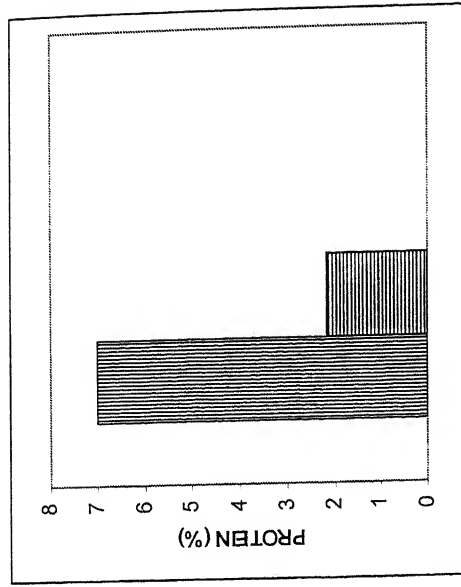
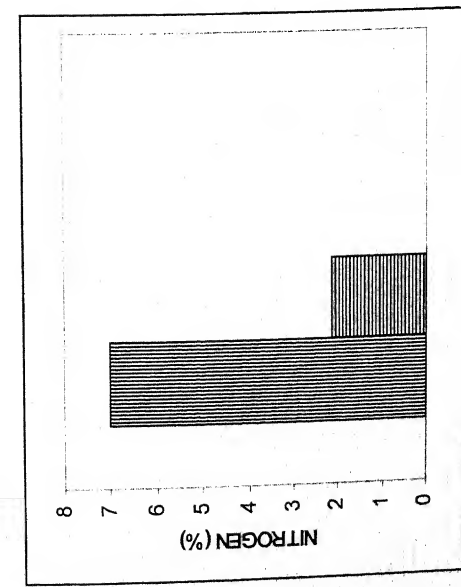
ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water, C.D. = Critical Difference.

GRAPH-22A EFFECT OF PRE-SOAKING SEED TREATMENT ON PERCENTAGE OF NITROGEN, PROTEIN, PHOSPHORUS, POTASSIUM OF MAIZE (R-49).



GRAPH-22B

EFFECT OF PRE-SOAKING SEED TREATMENT ON PERCENTAGE OF NITROGEN, PROTEIN, PHOSPHORUS, POTASSIUM OF MAIZE (R-49).



PERCENTAGE INCREASE

percent water and 1 percent ether extracts given for 6, 12 and 24 hrs are significant at 5 percent error probability.

TOTAL PROTEIN CONTENTS OF SEEDS :

Results given in Table-22 and Graph-22A, 22B exhibit that effect on total protein goes hand in hand with nitrogen content. 1 percent ether extract and 24 hrs treatments being more effective than 1 percent water extract and 24 hrs treatments. However, maximum increase in protein contents over control has been witnessed in treatments with 1 percent ether extract given as in 24 hrs pre-soaking seed treatments.

Statistical analysis of data shows that observed increases with 1 percent water and 1 percent ether extracts given for 6, 12 and 24 hrs are significant at 5 percent error probability.

PHOSPHORUS CONTENTS OF SEEDS :

A perusal of results given in Table-22 and Graph-22A, 22B show that total phosphorus contents of seeds

(Mg/100 gms) increase over control in 1 percent water and 1 percent ether extracts. However, the effect of later is more pronounced than that of former. A comparison of effect of 6, 12 and 24 hrs treatments show application of 24 hrs is more effective.

Results were statistically analysed following analysis of variance method and observed increases with 1 percent water and 1 percent ether extracts given for 6, 12 and 24 hrs are significant at 5 percent error probability.

POTASSIUM CONTENTS OF SEEDS :

A perusal of results given in Table-22 and Graph-22A, 22B show that total potassium contents of seeds (Mg/100 gms) increase over control in 1 percent water and 1 percent ether extracts. However, the effect of later is more pronounced than that of former. A comparison of effect of 6, 12 and 24 hrs treatments shows that application of 24 hrs is more effective.

CHAPTER 4

MORPHO-ANATOMICAL
RESPONSE OF MAIZE TO
Spirodella polyrhiza EXTRACTS
AND ITS SIGNIFICANCE.

STUDIES ON MORPHO-ANATOMICAL RESPONSE OF MAIZE TO *Spirodella polyrhiza* EXTRACTS AND ITS SIGNIFICANCE

Morpho-anatomical response of maize plants to pre-soaking seed treatment for 6 and 12 hrs have been investigated. Observations on root, stem and epidermal structures have been studied with regards to effects on diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundle, size of metaxylem and number of metaxylem (root); diameter of stem, number of vascular bundles, diameter of xylem, diameter of phloem and diameter of tracheids (stem); number of stomata, perimeter of single stomatal opening, number of epidermal cells length of epidermal cells and breadth of epidermal cells (epidermal structures) and discussed as under:

RESPONSE OF MAIZE VARIETY AZAD UTTAM :

INFLUENCE OF 6 HRS PRE-SOAKING ON ROOT :

Effect on Diameter of Root :

The effect of water and ether extracts have been recorded in Table-23. Different concentrations (0.5, 1, 2 and

TABLE - 23 :
RESPONSE OF MAIZE (AZAD UTTAM) ROOT TO 6 HRS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS (AVERAGE OF 25 REPLICATES)

KIND OF EXTRACT	DIAMETER OF ROOT IN μ					DIAMETER OF STELE IN μ					DIAMETER OF VASCULAR BUNDLE IN μ					NUMBER OF VASCULAR BUNDLES					SIZE OF METAXYLEM IN μ					NUMBR OF METAXYLEM				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
Water Extract	1010.0	1010.0	1045.0	1065.0	1200.0	445.10	459.9	471.5	475.2	499.5	137.0	139.5	159.2	167.1	170.0	15.0	15.2	15.2	15.2	16.9	61.00	68.5	75.0	76.0	76.1	5.5	5.6	5.7	6.7	6.9
	1010.0	1041.0	1105.0	1150.0	1221.0	445.1	462.2	487.5	501.2	531.5	135.0	141.5	169.5	171.5	183.3	15.0	15.2	15.8	15.9	17.1	61.0	72.0	78.3	79.2	81.5	5.5	6.0	6.4	6.9	7.5
	1010.0	1041.0	1105.0	1150.0	1221.0	445.1	462.2	487.5	501.2	531.5	135.0	141.5	169.5	171.5	183.3	15.0	15.2	15.8	15.9	17.1	61.0	72.0	78.3	79.2	81.5	5.5	6.0	6.4	6.9	7.5
Ether Extract	1010.0	1041.0	1105.0	1150.0	1221.0	445.1	462.2	487.5	501.2	531.5	135.0	141.5	169.5	171.5	183.3	15.0	15.2	15.8	15.9	17.1	61.0	72.0	78.3	79.2	81.5	5.5	6.0	6.4	6.9	7.5

C.D. = 41.48

Statistical Diff.5%W -C = 190
Analysis Diff.5% EW-C = 211

C.D. = 17.52

Diff.5%W -C = 54.4
Diff.5%EW-C = 86.4

C.D. = 7.07

Diff.5% W-C = 33.0
Diff.5%EW-C = 48.3

C.D. = 0.30

Diff.5% W-C = 1.9
Diff.5%EW-C = 2.1

C.D. = 2.41

Diff.5% W-C = 15.1
Diff.5%EW-C = 20.5

C.D. = 0.36

Diff.5% W-C = 1.4
Diff.5%EW-C = 2.0

ABBREVIATIONS USED : C = Control, W= Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

5 percent) of water and ether extracts impart increase in diameter of root except in case of 0.5 percent water extract. However, effect of ether extracts is more pronounced. Maximum diameter of root has been observed in 5 percent treatment with ether extract.

Results have been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Diameter of Stele :

The effect of water and ether extracts have been recorded in Table-23. Different concentrations (0.5, 1, 2 and 5 percent) of water and ether extract impart increase in diameter of stele. However, effect of ether extracts is more pronounced. Maximum diameter of stele has been observed in 5 percent treatment with water and ether extracts.

The data has been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Diameter of Vascular Bundle :

A perusal of Table-23 shows that effect of various concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts exercise an increase in diameter of vascular bundles except in case of 0.5 percent water extract. Both water and ether extracts in concentrations of 5 percent are maximum effective. However, the effect of later is more pronounced than that of former.

Statistical analysis of results shows that observed increases with 5 percent water and ether extracts are significant at 5 percent error probability.

Effect on Number of Vascular Bundles :

Observations given in Table-23 shows that 0.5 percent extracts of water and ether extracts yield no increase in number of vascular bundles. However, 5 percent water and ether extracts increase number of vascular bundles to the similar extent.

Results have been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Size of Metaxylem :

The effect of water and ether extracts has been recorded in Table-23. Different concentration (0.5, 1, 2 and 5 percent) of water and ether extract impart increase in size of metaxylem. However, effect ether extract is more pronounced. Maximum size of metaxylem has been observed in 5 percent treatment with water and ether extracts.

The data has been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Number of Metaxylem :

A perusal of Table-23 shows that effect of various concentrations (0.5, 1, 2 and 5 percent) of water and ether extract exercise an increase in number of metaxylem except in case of 0.5 percent water extract. Both water and ether extracts in concentrations of 5 percent are maximum effective however, the effect of later is more pronounced than that of former.

Results have been statistically analysed following analysis of variance method and effect of 5 percent water and ether

extracts are found to be significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING OF ROOT :

Effect on Diameter of Root :

The effect of water and ether extracts have been recorded in Table-24 and Photo-12. Different concentrations (0.5, 1, 2 and 5 percent) of water and ether extract impart increase in diameter of root. Although various concentrations (0.5, 1 and 2 percent) of ether extract are comparatively more effective than same concentrations of water extract but 5 percent water extract marks better results than 5 percent ether extract.

Results have been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Diameter of Stele :

The effect of water and ether extracts have been recorded in Table-24 and Photo-12. Different concentrations (0.5, 1, 2 and 5 percent) of water and ether extract impart increase in diameter of stele. However, effect of ether extract is more pronounced. Maximum diameter of stele has been

TABLE - 24 :

RESPONSE OF MAIZE (AZAD UTTAM) ROOT TO 12 HRS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS (AVERAGE OF 25 REPLICATES)

KIND OF EXTRACT	DIAMETER OF ROOT IN μ					DIAMETER OF STELE IN μ					DIAMETER OF VASCULAR BUNDLE IN μ					NUMBER OF VASCULAR BUNDLES					SIZE OF METAXYLEM IN μ					NUMBER OF METAXYLEM				
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
Water Extract	950.0	975.0	997.5	1055.0	1087.5	442.5	445.0	450.5	487.0	521.0	135.0	146.5	152.5	161.5	170.0	16.0	16.5	16.7	16.8	17.5	57.0	69.0	72.0	76.5	81.5	7.8	8.0	8.0	8.10	8.20
	950.0	995.0	1050.0	1070.0	1075.0	442.5	445.0	455.0	490.0	530.0	135.0	149.0	157.5	164.0	173.0	16.0	17.0	17.10	17.6	17.8	57.0	70.0	74.0	78.0	89.5	7.9	8.0	8.0	8.0	8.0
Ether Extract	950.0	995.0	1050.0	1070.0	1075.0	442.5	445.0	455.0	490.0	530.0	135.0	149.0	157.5	164.0	173.0	16.0	17.0	17.10	17.6	17.8	57.0	70.0	74.0	78.0	89.5	7.9	8.0	8.0	8.0	8.0

C.D. = 30.49

C.D. = 4.64

C.D. = 2.22

C.D. = 0.36

C.D. = 0.11

Statistical Diff. 5%W-C = 137.5

Diff. 5%W-C = 78.5

Diff. 5%W-C = 35

Diff. 5%W-C = 1.5

Diff. 5%W-C = 24.5

Diff. 5%W-C = 0.4

Analysis Diff. 5%EW-C = 125

Diff. 5%EW-C = 87.5

Diff. 5%EW-C = 38

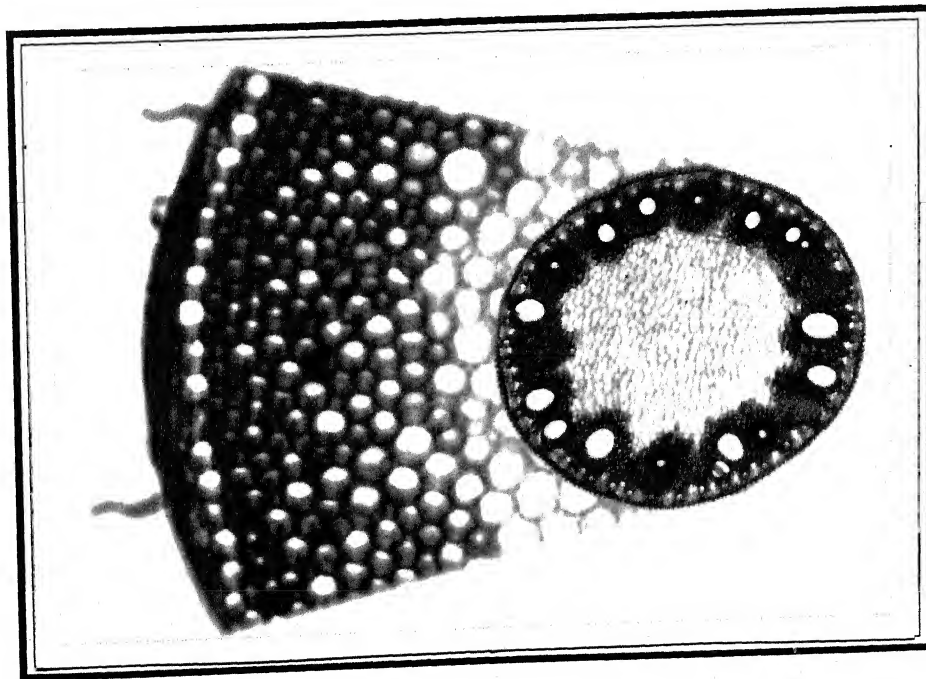
Diff. 5%EW-C = 1.8

Diff. 5%EW-C = 32.5

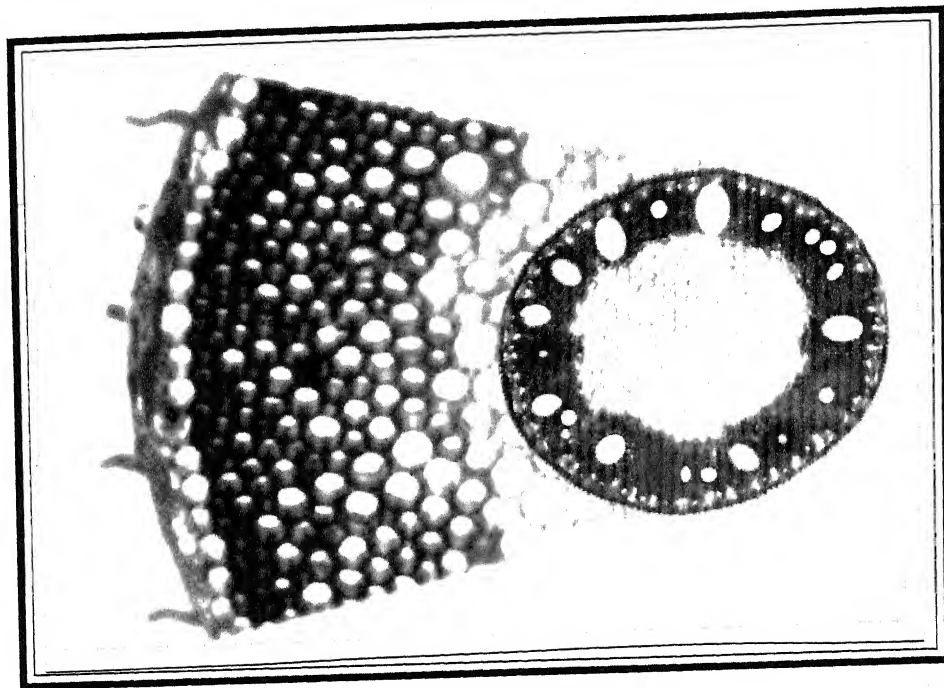
Diff. 5%EW-C = 0.2

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

PHOTO - 12: EFFECT OF 12 HRS. TREATMENT WITH EXTRACTS OF *Spirodella polyrhiza* ON MAIZE
(AZAD UTTAM) ROOT.



Control



5 % ETHER WATER-EXTRACT

observed in 5 percent treatment with ether extract.

The data has been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Diameter of Vascular Bundle :

A perusal of Table-24 and Photo-12 show that effect of various concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts exercise and increase in diameter of vascular bundles. Both water and ether extracts in concentrations of 5 percent are maximum effective. However, the effect of later is more pronounced than that of former.

Statistical analysis of results show that observed increases with 5 percent water and ether extracts are significant at 5 percent error probability.

Effect on Number of Vascular Bundles :

Observations given in Table-24 and Photo-12 show that effect of 0.5, 1 and 2 percent water and ether extracts are indential. However, 5 percent of both kinds of extracts marks an increase in number of vascular bundle over control, the effect of ether extract in more pronounced.

Results have been statistically analysed following of variance method and effect of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Size of Metaxylem :

The effect of water and ether extracts have been recorded in Table-24 and Photo-12. Different concentrations (0.5, 2 and 5 percent) of water and ether extract impart increase in size of metaxylem. However, effect of ether extract is more pronounced. Maximum size of metaxylem has been observed in 5 percent treatment with ether extract.

The data has been statistically analysed following analysis of variance method and effects of 5 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Number of Metaxylem :

A perusal of Table-24 and Photo-23 show that there is no effect of various concentration (0.5, 1, 2 and 5 percent) of water and ether extracts on number of metaxylem.

Statistical analysis of data shows that effect of treatments is insignificant at 5 percent error probability.

INFLUENCE ON STEM :

Effect on Diameter of Stem :

Results on influence of 6 and 12 hrs with 5 percent water and ether extracts on diameter of stem have been given in Table-25 and Photo-13. The data is suggestive that diameter of stem enlarges under both 6 and 12 hrs treatment. However, maximum effectiveness with 5 percent ether extract is similar under 6 and 12 hrs treatments.

Results were statistically analysed following analysis of variance method and observed increases in diameter with various treatments have been found to be statistically significant at 5 percent error probability.

Effect on Number of Vascular Bundles :

A perusal of Table-25 and Photo-13 indicate that while 6 and 12 hrs pre-soaking treatments with 5 percent water and ether extracts mark increase in number of vascular bundles, effect of 12 hrs is more pronounced as compared to 6 hrs. However, maximum effect on number of vascular bundles is witnessed with 5 percent ether extract under 12 hrs treatment.

Statistical analysis of data shows that effect of 5 percent water and ether extract (6 hrs treatments) and 5 percent ether

TABLE - 25 :

RESPONSE OF MAIZE (AZAD UTTAM) STEM TO PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS (AVERAGE OF 25 REPLICATES)

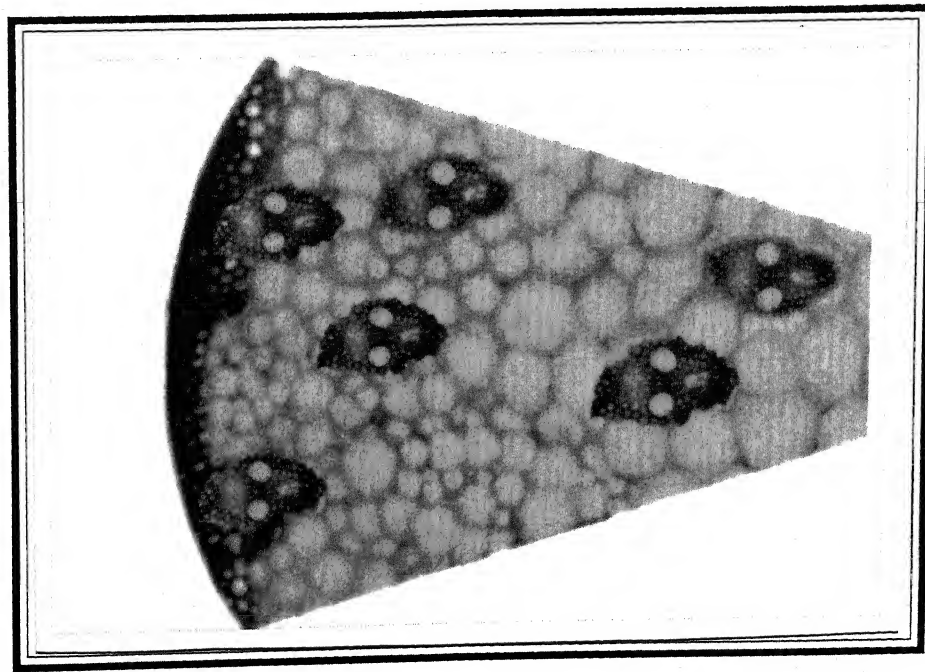
PRE-SOAK- ING PE- RIOD OF SEEDS	DIAMETER OF STEM IN μ	NUMBER OF VASCULAR BUNDLES PER MICROSCOPIC FIELD OF 1984 S.q. μ	DIAMETER OF XYLEM TISSUE IN μ	DIAMETER OF PHLOEM TISSUE IN μ	DIAMETER OF TRACHEIDS IN μ		
					METAXYLEM	PROTOXYLEM	
	C	5%W	5%EW	C	5%W	5%EW	C

6 hrs	4102.00	4981.00	5214.00	30.5	31.6	32.8	73.00	89.8	95.5	38.00	58.00	61.5	30.00	45.5	48.5	20.00	23.5	28.00
12 hrs	4225.00	5021.00	5354.5	31.00	32.00	33.80	74.00	94.00	99.5	40.00	58.00	63.00	33.00	48.5	52.5	22.50	25.00	31.00

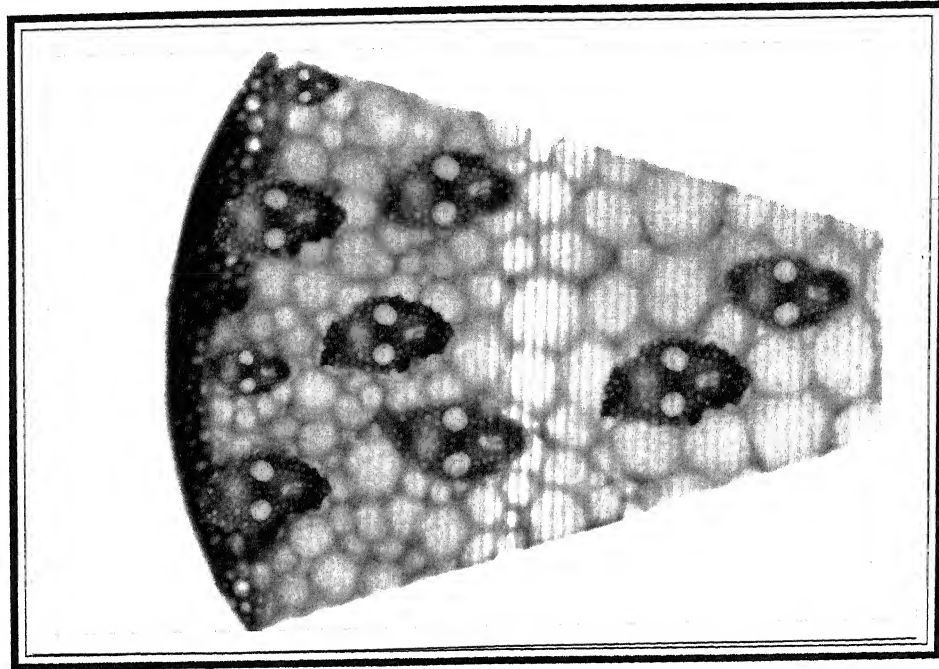
C.D.= 132.68		C.D. = 0.8		C.D. = 4.45		C.D. = 2.59		C.D. = 1.43		C.D. = 1.9	
<u>6 hrs treatment</u>		<u>6 hrs treatment</u>		<u>6 hrs treatment</u>		<u>6 hrs treatment</u>		<u>6 hrs treatment</u>		<u>6 hrs treatment</u>	
Diff.5%W -C = 879		Diff.5%W -C = 1.1		Diff.5% W-C = 16.8		Diff.5% W-C = 20		Diff.5% W-C = 15.5		Diff.5% W-C = 3.5	
Diff.5% EW-C = 1112		Diff.5%EW-C = 2.3		Diff.5%EW-C = 22.5		Diff.5%EW-C = 23.5		Diff.5%EW-C = 18.5		Diff.5%EW-C = 8.0	
<u>12 hrs treatment</u>		<u>12 hrs treatment</u>		<u>12 hrs treatment</u>		<u>12 hrs treatment</u>		<u>12 hrs treatment</u>		<u>12 hrs treatment</u>	
Diff.5% W-C = 796.5		Diff.5% W-C = 1		Diff.5% W-C = 20		Diff.5% W-C = 18		Diff.5% W-C = 15.5		Diff.5% W-C = 2.5	
Diff.5%EW-C = 1129.5		Diff.5%EW-C = 2.8		Diff.5%EW-C = 25.5		Diff.5%EW-C = 23		Diff.5%EW-C = 19.5		Diff.5%EW-C = 8.5	

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

PHOTO - 13: EFFECT OF 12 HRS. TREATMENT WITH EXTRACTS OF *Spirodella polyrhiza* ON MAIZE (AZAD UTTAM) STEM.



Control



5 % ETHER WATER-EXTRACT

extract (12 hrs treatments) are significant at 5 percent error probability.

Effect on Diameter of Xylem :

Observation given in Table-25 and Photo-13 indicate that while 6 and 12 hrs pre-soaking treatments with 5 percent water and ether extracts mark increase in diameter of xylem tissue, effect of 12 hrs is more pronounced as compared to 6 hrs. However, maximum effect on diameter of xylem tissue is witnessed with 5 percent ether extract under 12 hrs treatment.

Results were statistically analysed following analysis of variance method and observed increases in diameter with various treatments have been found to be statistically significant at 5 percent error probability.

Effect on Diameter of Phloem :

A perusal of Table-25 and Photo-13 indicate that while 6 hrs and 12 hrs pre-soaking treatments with 5 percent water and ether extracts mark increase in diameter of phloem tissue. Effect of 12 hrs is more pronounced as compared to 6 hrs. However, maximum effect on diameter of phloem tissue is witnessed with 5 percent ether extract under 12 hrs treatment.

Observations were statistically analysed following analysis of variance method and observed increases in diameter with various treatments have been found to be statistically significant at 5 percent error probability.

Effect on Diameter of Tracheids :

Observations given in Table-25 and Photo-13 on diameter of metaxylem and protoxylem tracheids show a marked effect with 6 and 12 hrs treatments of 5 percent water and ether extracts. However, diameter of metaxylem and protoxylem tracheid is maximum under 12 hrs treatment with 5 percent ether extract. Effect of 5 percent water extracts and 6 hrs treatments are comparatively lesser.

Results were statistically analysed and data is suggestive of the fact that while observed effects with various treatments on diameter of metaxylem are significant, treatment with 5 percent ether extract given as 12 hrs treatment is only significant with respect to diameter of protoxylem.

INFLUENCE OF 6 HRS PRE-SOAKING ON STOMATAL AND EPIDERMAL DEVELOPMENT :

Effect on Number of Stomata :

Influence of pre-soaking seed treatment with *S. polyrhiza* with extracts on number of stomata has been recorded in Table-26. Results indicate that number of stomata markedly increases with different concentration of extract (0.5, 1, 2 and 5 percent). The effect gradually increase with increase in concentration of extract on both upper and lower surface of leaves. Number of stomata is higher on lower surface and maximum number of stomata has been observed with 5 percent ether extract on lower epidermis of leaves.

Statistical analysis of data shows that observed increase in number of stomata with 5 percent water (lower epidermis) and ether (Upper and lower epidermis) extract are significant at 5 percent error probability.

Effect on Perimeter of Single Stomatal Opening :

Results given in Table-26 shows that treatment with different concentration of (0.5, 1, 2 and 5 percent) extracts bring about an increase in perimeter to an appreciable extent. Influence of treatment increases with gradual increase in concentration of extract applied. Perimeter of single stomatal

TABLE - 26 :

RESPONSE OF EPIDERMIS OF MAIZE (AZAD UTTAM) LEAVES TO 6 HRS PRE-SOAKING SEED TREATMENT
WITH *Spirodella polyrhiza* EXTRACTS (AVERAGE OF 25 REPLICATES)

KIND OF EXTRACT	SURFACE	NUMBER OF STOMATA PER MICROSCOPIC FIELD OF 1984 S.q. μ					PERIMETER OF SINGLE STOMATAL OPENING IN μ					NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD OF 1984 S.q. μ					LENGTH OF EPIDERMAL CELLS IN μ					BREADTH OF EPIDERMAL CELLS IN μ				
		C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
Water Extract	Upper	5.0	5.1	5.2	5.4	5.8	69.0	72.0	74.1	80.2	90.1	29.0	29.8	32.0	30.9	32.6	110.2	137.2	125.0	121.5	116.6	33.1	30.4	26.3	30.4	32.5
	Lower	6.5	5.4	5.7	6.5	8.0	73.6	75.1	78.9	85.5	97.4	33.8	31.5	31.5	32.6	30.5	111.5	126.8	121.6	121.1	116.6	27.5	25.8	21.0	30.4	36.5
Ether Extract	Upper	5.1	5.3	5.7	6.3	7.4	63.0	76.8	79.9	87.7	93.1	28.3	30.2	33.4	35.0	31.8	108.5	125.1	116.4	128.3	140.3	33.1	30.8	27.1	29.1	27.5
	Lower	6.6	6.5	6.8	6.7	7.8	73.6	79.8	85.5	96.0	102.3	33.6	31.1	32.7	31.5	36.5	109.1	136.5	134.4	122.4	136.0	27.5	22.5	21.1	29.1	22.2

C.D. = 0.56

C.D. = 4.02

C.D. = 2.73

C.D. = 4.4

C.D. = 9.97

Upper surfaceUpper surfaceUpper surfaceUpper surfaceUpper surface

Diff. 5%W -C = 0.8

Diff. 5%W -C = 21.11

Diff. 5% W-C = 3.6

Diff. 0.5% W-C = 27.1

Diff. 5% W-C = 0.6

Diff. 5% EW-C = 2.3

Diff. 5%EW-C = 30.1

Diff. 2%EW-C = 6.7

Diff. 5%EW-C = 31.8

Diff. 0.5%EW-C = 2.3

Statistical Analysis

Lower surfaceLower surfaceLower surfaceLower surfaceLower surface

Diff. 5%W -C = 1.5

Diff. 5%W -C = 23.8

Diff. 2% W-C = 1.2

Diff. 2% W-C = 10.1

Diff. 5% W-C = 9

Diff. 5% EW-C = 1.2

Diff. 5%EW-C = 28.7

Diff. 5%EW-C = 2.9

Diff. 0.5%EW-C = 27.4

Diff. 2%EW-C = 1.6

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

opening on lower epidermis is larger and maximum effect is observed in case of 5 percent ether extract on lower epidermis.

Results with 5 percent water and ether extracts have been found to be statistically significant for both lower and upper epidermis.

Effect on Number of Epidermal Cells :

Observations given in Table-26 shows that the effect of treatment water extract with 5 percent and 2 percent on upper and lower epidermis respectively, and 2 and 5 percent with ether extract on upper and lower epidermis respectively exercises maximum effect on number of epidermal cells per unit area. Observed effect is slightly inconsistent.

Statistical analysis of data shows that observed increases in number of epidermal cells with 5 percent water extract on upper epidermis and 2 and 5 percent ether extracts on upper and lower epidermis respectively are significant at 5 percent error probability at 5 percent error probability.

Effect on Length of Epidermal Cells :

Observations given in Table-26 shows that 0.5 and 2 percent water extract on upper and lower epidermis respectively, and 5 and 0.5 percent of ether extract on upper and lower epidermis respectively. Exercises maximum increase in length

of epidermal cells. Maximum length of epidermal cells has been observed with 0.5 percent ether extract on lower epidermis. Trend of result on effect of different concentrations are inconsistent.

Statistical analysis of result shows that observed increases with maximum effective concentrations is significant at 5 percent error probability.

Effect on Breadth of Epidermal Cells :

A perusal of Table-26 shows that effect of treatments with *S. polyrhiza* extracts on breadth of epidermal cells is inconsistent and there is no regular pattern of effect with increase or decrease in concentrations of extract applied. However, water extract marks maximum breadth of epidermal cells in 5 percent treatment on upper and lower epidermis. Likewise ether extract shows maximum breadth of epidermal cells with 0.5 and 2 percent on upper and lower epidermis respectively. In case of water and ether extracts on upper epidermis breadth is less than control.

Statistical analysis of result shows that observed increase with 5 percent water extract on lower epidermis is significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING ON STOMATAL AND EPIDERMAL DEVELOPMENT :

Effect on Number of Stomata :

Influence of pre-soaking seed treatment with *S. polyrhiza* extracts on number of stomata have been recorded in Table-27 and Photo-14, 15. Result indicate that number of stomata markedly increases with different concentration of extracts (0.5, 1, 2 and 5 percent). The effect gradually increases with increase in concentration of extract on both upper and lower surfaces of leaves. Number of stomata is higher on lower surface and maximum number of stomata has been observed with 5 percent ether extract on lower epidermis of leaves.

Statistical analysis of data shows that 5 percent water and ether extracts have been found to be statistically significant for both lower and upper epidermis at 5 percent error probability.

Effect on Perimeter of Single Stomatal Opening :

Results given in Table-27 and Photo-14, 15 show that treatment with different concentrations of extracts (0.5, 1, 2 and 5 percent) brings about an increase in perimeter to an appreciable extent. Influence of treatment increases with

TABLE - 27 :
RESPONSE OF EPIDERMIS OF MAIZE (AZAD UTTAM) LEAVES TO 12 HRS. PRE-SOAKING SEED TREATMENT
WITH *Spirodella polyrhiza* EXTRACT (AVERAGE OF 25 REPLICATES)

KIND OF EXTRACT	SURFACE	NUMBER OF STOMATA PER MICROSCOPIC FIELD OF 1984 S.q. μ					PERIMETER OF SINGLE STOMATAL OPENING IN μ					NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD OF 1984 S.q. μ					LENGTH OF EPIDERMAL CELLS IN μ					BREADTH OF EPIDERMAL CELLS IN μ				
		C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
Water Extract	Upper	6.0	6.4	8.1	8.5	8.7	78.5	81.3	84.2	87.8	98.1	29.1	27.4	27.8	28.1	34.3	128.1	150.4	146.6	131.3	104.9	32.1	30.2	29.1	26.3	28.6
	Lower	6.6	6.8	8.6	8.8	9.2	85.9	89.4	93.1	96.9	105.0	31.4	32.6	38.1	31.4	38.2	139.2	141.4	102.5	153.2	135.5	26.1	23.0	33.2	27.0	24.2
Ether Extract	Upper	6.0	6.8	8.2	8.7	9.3	78.5	84.1	86.3	89.1	108.7	29.1	40.2	38.1	37.6	41.1	128.1	146.9	130.1	90.2	109.1	37.1	28.5	27.4	33.1	30.5
	Lower	6.6	7.1	8.8	9.0	9.5	85.9	91.2	96.7	99.3	119.4	31.4	38.0	28.9	37.0	42.7	139.2	130.2	143.6	117.4	88.5	26.1	28.3	28.9	26.3	24.6

C.D. = 0.19

C.D. = 3.84

C.D. = 4.45

C.D. = 25.67

C.D. = 4.54

Upper surface
Diff. 5%W -C = 2.7
Diff. 5% EW-C = 3.3

Upper surface
Diff. 5%W -C = 19.6
Diff. 5%EW-C = 28.2

Upper surface
Diff. 5% W-C = 5.2
Diff. 0.5%EW-C = 11.1

Upper surface
Diff. 0.5% W-C = 22.3
Diff. 0.5%EW-C = 18.8

Upper surface
Diff. 0.5% W-C = 1.9
Diff. 2%EW-C = 4

Statistical Analysis

Lower surface
Diff. 5%W -C = 2.6
Diff. 5% EW-C = 2.9

Lower surface
Diff. 5%W -C = 29.1
Diff. 5%EW-C = 35.5

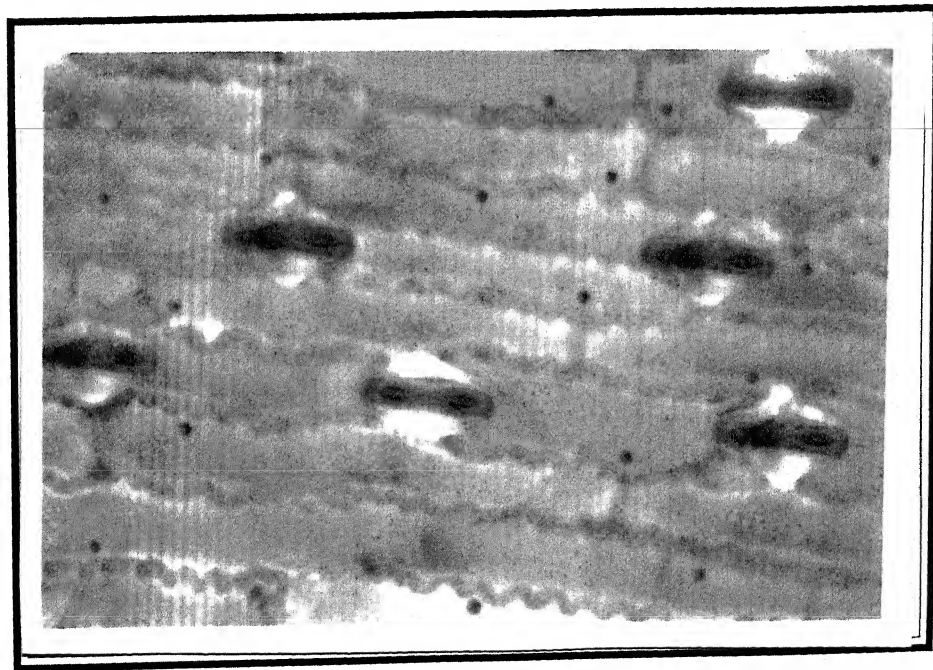
Lower surface
Diff. 1% W-C = 6.7
Diff. 5%EW-C = 11.3

Lower surface
Diff. 2% W-C = 14.0
Diff. 1%EW-C = 4.4

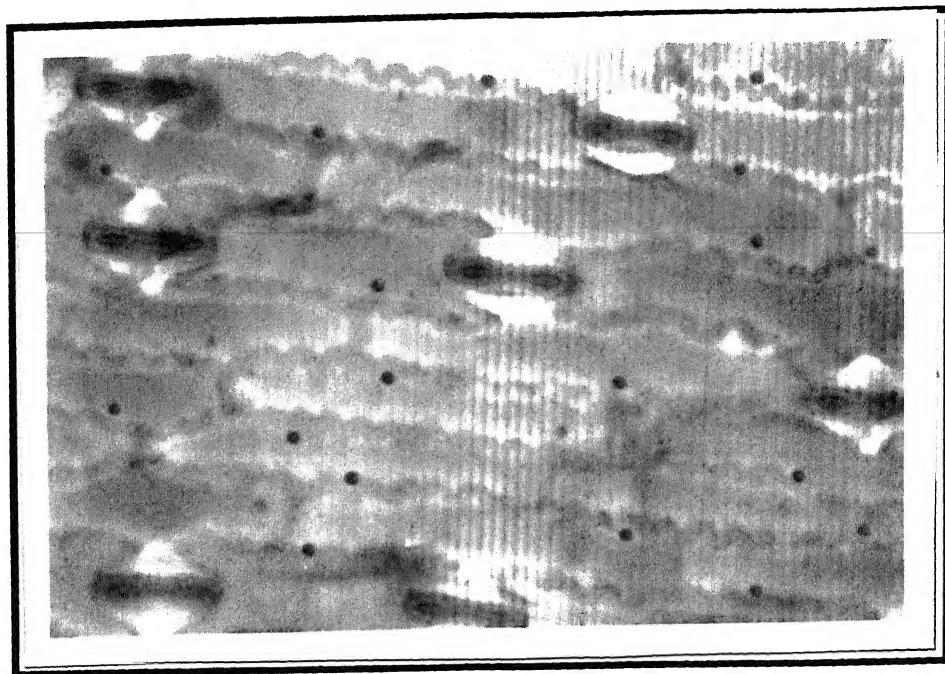
Lower surface
Diff. 1% W-C = 7.1
Diff. 1%EW-C = 2.8

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

PHOTO - 14: EFFECT OF 12 HRS. TREATMENT WITH *Spirodella polyrhiza* EXTRACTS OF ON UPPER EPIDERMIS OF MAIZE (AZAD UTTAM) LEAF.

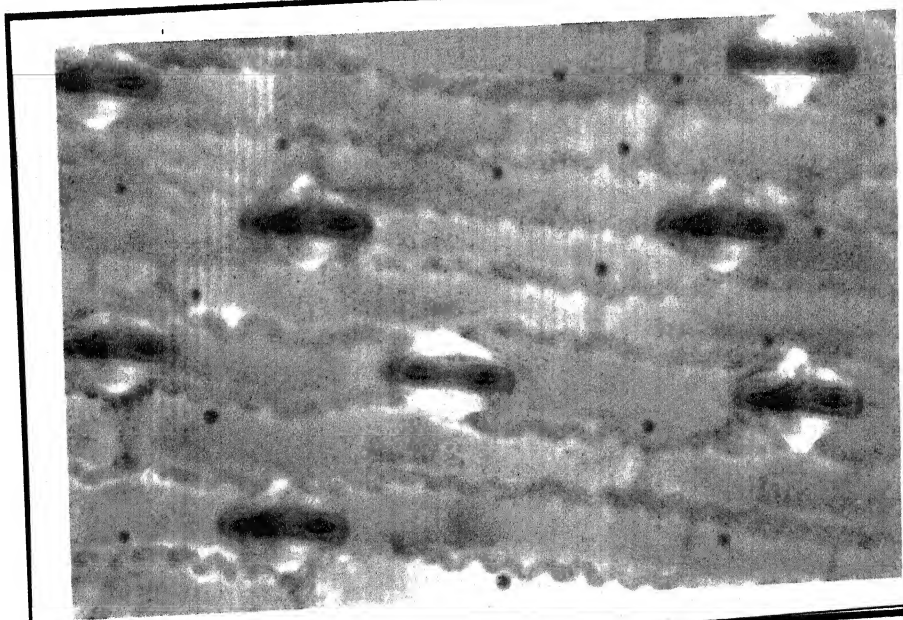


Control

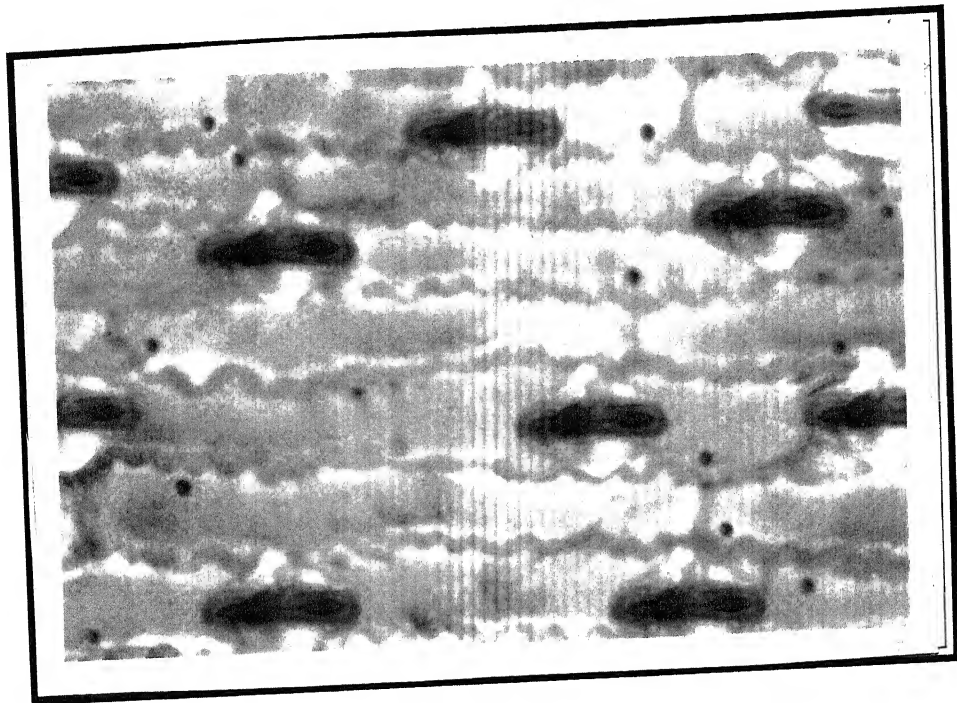


5 % ETHER WATER-EXTRACT

PHOTO - 15: EFFECT OF 12 HRS. TREATMENT WITH *Spirodella polyrhiza* EXTRACTS OF ON LOWER EPIDERMIS OF MAIZE (AZAD UTTAM) LEAF.



Control



5 % ETHER WATER-EXTRACT

gradual increase in concentration of extract applied. Perimeter of single stomatal opening on lower epidermis is larger and maximum effect is observed in case of 5 percent ether extract on lower epidermis.

Results with 5 percent water and ether extracts have been found to be statistically significant for both lower and upper epidermis at 5 percent error probability at 5 percent error probability.

Effect on Number of Epidermal Cells :

A perusal of Table-27 and Photo-14, 15 show that 5 and 1 percent water extract on upper and lower epidermis respectively, and 0.5 and 5 percent ether extracts on upper and lower epidermis respectively, exercise maximum increase in number of epidermal cells. Number of epidermal cells per unit area is higher on lower epidermis and highest number has been witnessed in 0.5 percent ether extract on upper epidermis.

Results were statistically analysed following analysis of variance method and observed increases with maximum effective concentrations of water and ether extracts on both upper and lower surfaces have been found to be significant at 5 percent probability.

Effect on Length of Epidermal Cells :

Observations given in Table-27 and Photo-14, 15 show that 0.5 and 2 percent water extract on upper and lower epidermis respectively, and 0.5 and 1 percent ether extract on upper and lower epidermis respectively, exercises maximum increase in length of epidermal cells. Maximum length of epidermal cells has been observed with 2 percent water extract on lower epidermis. Trend of results on effect of different concentrations are inconsistent.

Statistical analysis of results show that observed increases with maximum effective concentrations are insignificant at 5 percent error probability.

Effect on Breadth of Epidermal Cells :

Results given in Table-27 and Photo-14, 15 on effect of treatment on breadth of epidermal cells shows that the effect of various concentrations of extracts marks a decline in breadth as compared to control. However, there is some increase over control in 1 percent water extract on lower epidermis, 2 and 1 percent ether extract on upper and lower epidermis respectively. The trend of results on effect of different concentrations is slightly inconsistent.

Statistical analysis of data shows that effect of 1 percent water extract on lower epidermis is significant at 5 percent error probability.

RESPONSE OF MAIZE VARIETY R-49 :

INFLUENCE OF 6 HRS PRE-SOAKING ON ROOT :

Effect on Diameter of Root :

The effect of water and ether extracts has been recorded in Table-28. A perusal of data is suggestive of an increase with different concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts. The effect of ether extract is comparatively more pronounced than water extract. It has been observed that 1 percent water and ether extracts increase diameter of root to the maximum extent. However, lowering or increase in concentration of extracts exercise a gradual decline in diameter of root.

Results have been statistically analysed following analysis of variance method and effects of 1 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Diameter of Stele :

Observations on effect of pre-soaking seed treatment on diameter of stele has been recorded in Table-28. A perusal of data shows that different concentrations of water and ether extracts (0.5, 1, 2 and 5 percent) exercise a sustained beneficial effect. Effect of ether extract is more pronounced.

TABLE - 28 :
RESPONSE OF MAIZE (A-49) ROOT TO 6 HRS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza*
EXTRACTS (AVERAGE OF 25 REPLICATES)

KIND OF EXTRACT	DIAMETER OF ROOT IN μ					DIAMETER OF STELE IN μ					DIAMETER OF VASCULAR BUNDLE IN μ					NUMBER OF VASCULAR BUNDLES					SIZE OF METAXYLEM IN μ					NUMBR OF METAXYLEM					
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	
Water Extract	974.0	984.0	1120.0	1050.0	990.0	510.0	540.2	590.0	570.0	515.0	150.0	162.0	175.5	155.5	146.0	14.5	14.5	15.1	14.8	14.4	75.0	75.0	75.0	91.5	77.6	64.5	6.5	7.2	7.4	7.2	6.4
	974.0	995.0	1195.0	1075.0	1007.0	550.5	560.0	632.0	583.0	525.0	150.0	167.5	186.5	158.6	150.0	14.5	15.6	16.5	14.9	14.6	75.0	86.5	95.0	80.0	77.1		6.5	7.8	8.5	7.8	
Ether Extract																															

C.D. = 36.12

C.D. = 33.41

C.D. = 4.88

C.D. = 0.8

C.D. = 7.05

C.D. = 0.73

Statistical Diff. 1%W -C = 146.0

Diff. 1%W -C = 80.0

Diff. 1% W-C = 25.5

Diff. 1% W-C = 0.6

Diff. 1% W-C = 16.5

Analysis Diff. 1% EW-C = 221.0

Diff. 1%EW-C = 81.5

Diff. 1%EW-C = 36.2

Diff. 1%EW-C = 2

Diff. 1%EW-C = 20

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

Maximum diameter of stele observed in treatment with 1 percent water and ether extracts. A gradual decline in diameter was observed with corresponding increase or decrease in concentration of extracts applied.

Statistical analysis of the results obtained is suggestive of significant increase in diameter of stele with 1 percent water and ether extracts at 5 percent error probability.

Effect on Diameter of Vascular Bundle :

An examination of data given in Table-28 shows that there is an increase in diameter of vascular bundle with various concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts, except effect of 5 percent water extract marks a decline as compared to control. The beneficial effect is maintained through out the duration of experiment. Treatment with 1 percent water and ether extracts increase diameter of vascular bundle to the maximum extent covering as well as increase in concentrations of extracts gradually redces the effect.

Results obtained were statistically analysed and the data showed that observed increases with 1 percent water and ether extracts are found of be significant at 5 percent error probability.

Effect on Number of Vascular Bundles :

A perusal of Table-28 shows that effect of various concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts exercise an increase in number of vascular bundles except in case of 0.5 percent water extract. However effect of ether extract is more pronounced. Maximum number of vascular bundles had been observed in 1 percent treatment with water and ether extracts. Lowering or increase in concentration results in a declining effect of extracts.

Statistical analysis of data suggests that observed increases in number of vascular bundles with 1 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Size of Metaxylem :

The effect of water and ether extracts has been recorded in Table-28. Different concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts impart an increase in size of metaxylem except in case of 0.5 percent water extract. Effect of 5 percent water extracts marks a decline as compared to control. However, effect of ether extract is more pronounced. Maximum size of metaxylem has been observed in 1 percent treatment with water and ether extracts. Lowering or increase

in concentration of extracts correspondingly reduces the influence.

The data was statistically analysed following analysis of variance method and the effects of 1 percent water and ether extracts have been found to be significant at 5 percent error probability.

Effect on Number of Metaxylem :

Observations given in Table-28 is suggestive that is a sustained beneficial effect of different concentrations (0.5, 1, 2 and 5 percent) of water and ether extrats, except effect of 5 percent water extract marks a decline as compared to control. The effect of ether extract is more marked than water extract. However, maximum increase in number of metaxylem appeared with 1 percent water and ether extracts. Lowering as well as increase in concentration of extracs gradually reduces the effect.

Statistical analysis of results show that effect of 1 percent water and ether extracts are found to be significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING ON ROOT :

Effect on Diameter of Root :

The effect of water and ether extracts have been recorded in Table-29 and Photo-16. A perusal of data is suggestive of an increase with different concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts. The effect of ether extract is comparatively more pronounced than water extract. It has been observed that 1 percent water and ether extracts increase diameter of root to the maximum extent. However, lowering of increase in concentrations of extracts exercises a gradual decline in diameter of root.

Results have been statistically analysed following analysis of variance method and effect of 1 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Diameter of Stele :

Observations on effect of pre-soaking seed treatment on diameter of stele have been recorded in Table-29 and Photo-16. A perusal of data shows that different concentrations of water and ether extracts (0.5, 1, 2 and 5 percent) exercise a sustained beneficial effect, except effect of 5 percent water extract marks a decline as compared to control. Effect of ether

TABLE - 29 :

RESPONSE OF MAIZE (R-49) ROOT TO 12 HRS PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS (AVERAGE OF 25 REPLICATES)

KIND OF EXTRACT	DIAMETER OF ROOT In μ					DIAMETER OF STELE In μ					DIAMETER OF VASCULAR BUNDLE IN μ					NUMBER OF VASCULAR BUNDLES					SIZE OF METAXYLEM IN μ					NUMBER OF METAXYLEM					
	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	
Water Extract	1100.0	1150.0	1235.0	1119.5	1119.5	570.0	575.0	645.0	525.0	525.0	185.0	189.0	212.0	185.0	185.0	14.5	15.5	15.7	14.4	14.2	68.5	70.2	81.5	65.5	65.5	6.5	6.7	6.9	7.0	6.7	6.2
Ether Extract	1100.0	1165.5	1255.5	1197.0	1197.0	570.0	581.0	693.5	585.0	577.0	185.0	193.0	223.0	193.0	190.0	14.5	157.7	16.0	14.4	14.2	68.5	72.5	81.5	69.0	68.5	6.5	6.5	6.9	7.0	6.7	6.4

C.D. = 45.52

C.D. = 34.83

C.D. = 5.23

C.D. = 0.18

C.D. = 1.81

C.D. = 0.14

Statistical Diff. 1%W -C = 135

Diff. 1%W -C = 75

Diff. 1% W-C = 27

Diff. 1% W-C = 1.2

Diff. 1% W-C = 0.4

Analysis Diff. 1% EW-C = 155.5

Diff. 1%EW-C = 123.5

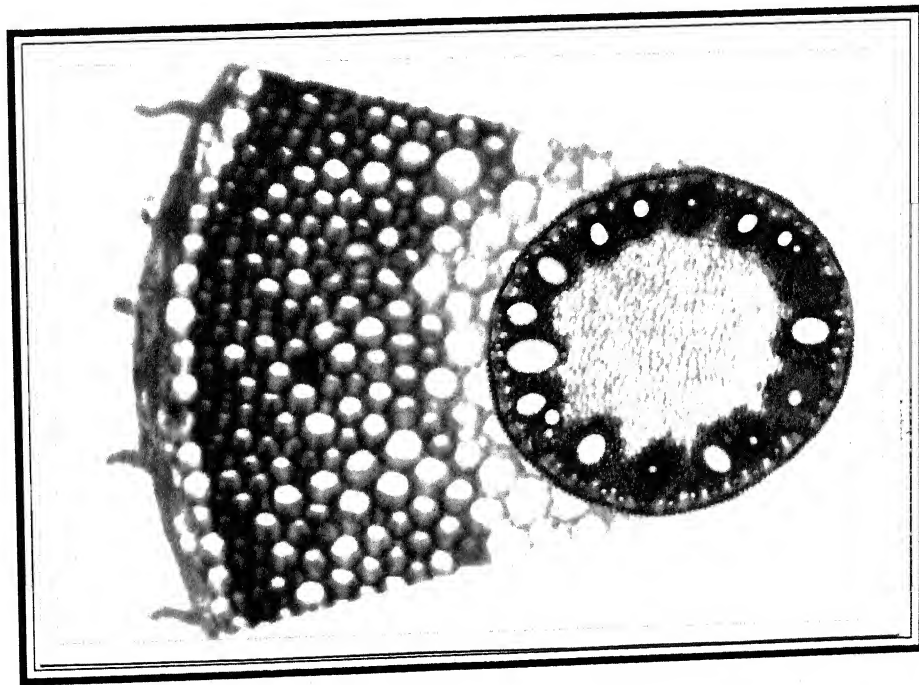
Diff. 1%EW-C = 38

Diff. 1%EW-C = 1.5

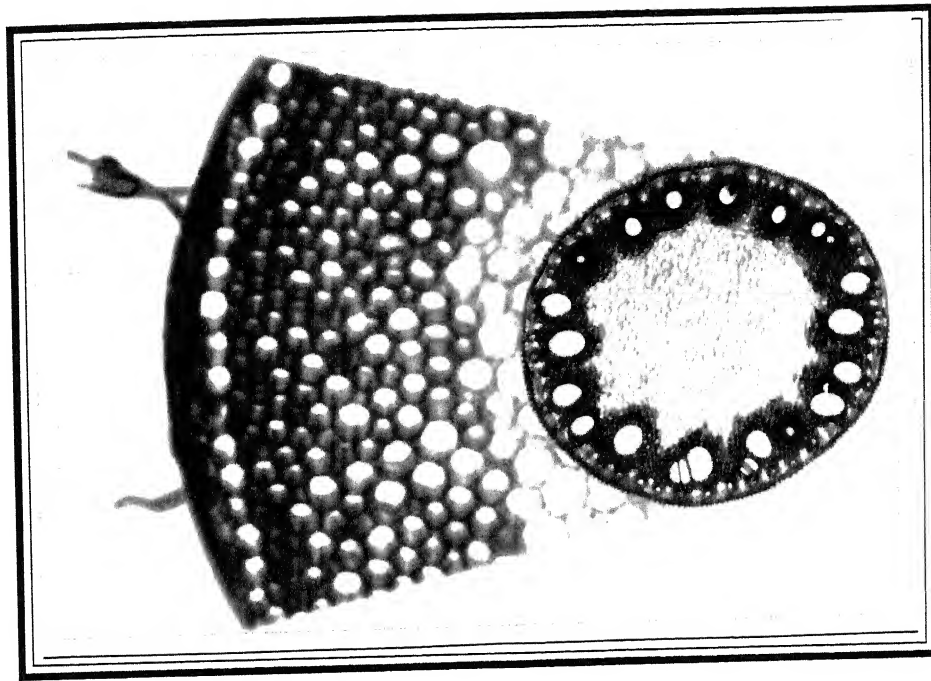
Diff. 1%EW-C = 0.5

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

PHOTO - 16: EFFECT OF 12 HRS. TREATMENT WITH EXTRACTS OF *Spirodella polyrhiza* ON MAIZE
(R-49) ROOT.



Control



1 % ETHER WATER-EXTRACT

extract is more pronounced. Maximum diameter of stele observed in treatment with 1 percent water and ether extracts. A gradual decline in diameter was observed with correspondingly increase or decrease in concentration of extracts applied.

Statistical analysis of the results obtained is suggestive of significant increase in diameter of stele with 1 percent water and ether and ether extracts at 5 percent error probability.

Effect on Diameter of Vascular Bundle :

An examination of data given in Table-29 and Photo-16 show that have been is an increase in diameter of vascular bundle with various concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts. The beneficial effect is maintained throughout the duration of experiment. Treatment with 1 percent water and ether extracts increase diameter or vascular to the maximum extent. Lowering as well as increase in concentration of extracts gradually reduces the effect.

Results obtained were statistically analysed and the data showed that observed increase with 1 percent water and ether extracts are found to be significant at 5 percent error probability.

Effect on Number of Vascular Bundles :

A perusal of Table-29 and Photo-16 show that effect of various concentrations (0.5, 1, 2 and 5 percent) of water and ether extracts exercise an increase in number of vascular bundles, except effect of 5 percent water extract marks a decline as compared to control. However, effect of ether extract is more pronounced. Maximum number of vascular bundles have been observed in 1 percent treatment with water and ether extracts. Lowering or increase in concentration result a declining effect of extracts.

Statistical analysis of data suggests that observed increase in number of vascular bundles with 1 percent ether extract is found to be significant but effect of water extract is insignificant at 5 percent error probability.

Effect on Size of Metaxylem :

The effect of water and ether extract have been recorded in Table-29 and Photo-16. Different concentrations (0.5, 1, 2 and percent) of water and ether extract impart increase in size of metaxylem, except effect of 2 and 5 percent water extracts marks a compared to control. However, effect of ether extracts is more pronounced. Maximum size of mataxylem has been observed in 1 percent treatment with water and ether

extracts. Lowering or increase in concentration of extracts correspondingly reduces the influence.

The data was statistically analysed following analysis of variance method and the effect of 1 percent water and ether extracts have been found to be significant at 5 percent error probability.

Effect on Number of Metaxylem :

Observations given in Table-29 and Photo-16 are suggestive that there is a sustained beneficial effect of different concentrations (0.5, 1 and 2 percent) of water and ether extracts. Effect of 5 percent water and ether extracts marks a decline as compared to control. The effect of ether extract is more marked than water extract. However, maximum increase in number of metaxylem appeared with 1 percent and ether extracts.

Statistical analysis of results shows that effect of 1 percent water and ether extracts are found to be significant at 5 percent error probability.

INFLUENCE ON STEM :

Effect on Diameter of Stem :

Results on influence of 6 and 12 hrs with 1 percent water and ether extracts on diameter of stem have been given in Table-30 and Photo-28. The data is suggestive that diameter of stem enlarges under both 6 and 12 hrs treatments, effects of 12 hrs are more pronounced as compared to 6 hrs. However, maximum effectiveness is with 1 percent ether extract and 12 hrs treatment.

Results were statistically analysed following analysis of variance method and observed increases in diameter with various treatments have been found to be statistically significant at 5 percent error probability.

Effect on Number of Vascular Bundles :

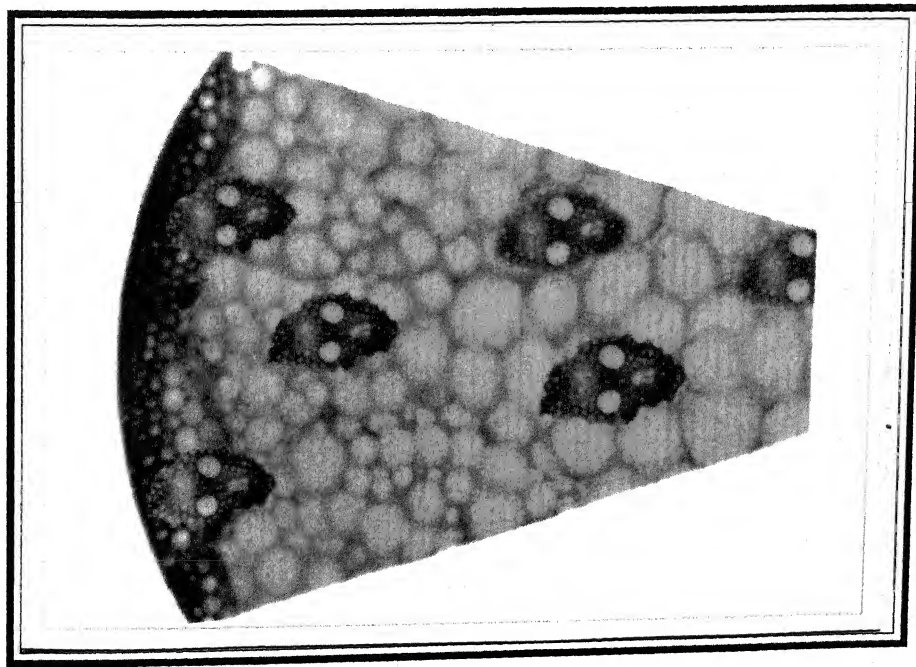
A perusal of Table-30 and Photo-17 indicate that while 6 and 12 hrs pre-soaking treatments with 1 percent water and ether extracts mark increase in number of vascular bundles, effect of 6 hrs is more pronounced as compared to 12 hrs. However, maximum effect on number of vascular bundles is witnessed with 1 percent ether extract under 6 hrs pre-soaking seed treatment.

TABLE - 30 : RESPONSE OF MAIZE (R-49) STEM TO PRE-SOAKING SEED TREATMENT WITH *Spirodella polyrhiza* EXTRACTS (AVERAGE OF 25 REPLICATES)

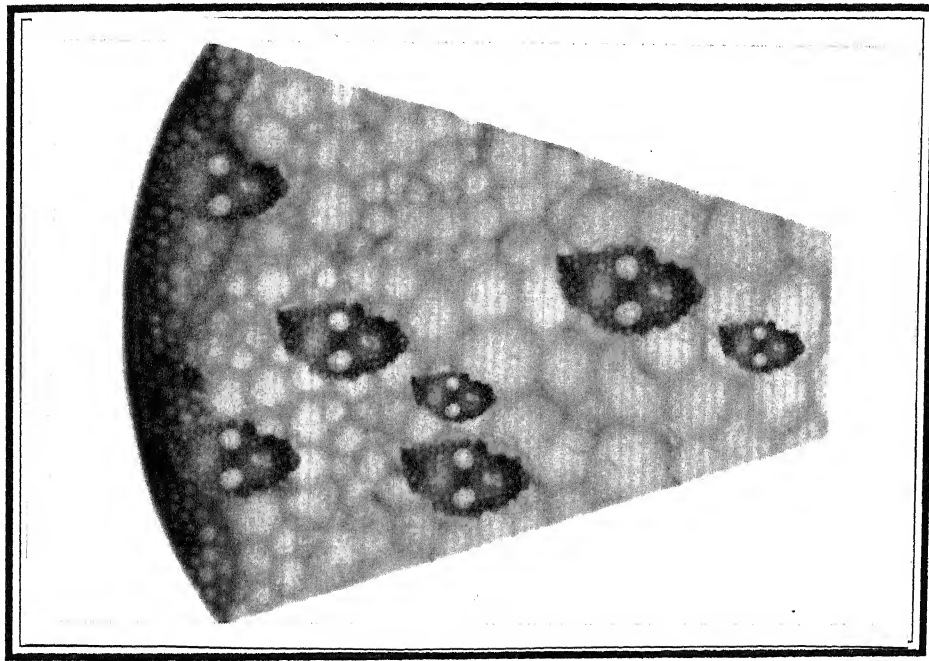
PRE-SOAK- ING PERIOD OF SEEDS	DIAMETER OF STEM IN μ	NUMBER OF VASCUAR BUNDLES PER MICROSCOPIC FIELD OF 1984 SQ. μ			DIAMETER OF XYLEM TISSUE IN μ			DIAMETER OF PHLOEM TISSUE IN μ			DIAMETER OF TRACHEIDS IN μ							
											METAXYLEM			PROTAXYLEM				
		C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW	C	1%W	1%EW		
6 hrs	3735.00	4210.00	4490.00	29.0	33.5	35.5	85.00	87.5	98.0	48.0	50.5	66.0	34.5	40.0	50.0	17.0	25.5	31.0
12 hrs	4250.00	4880.6	4852.0	28.5	30.0	31.0	95.3	95.3	98.0	52.0	58.0	61.5	45.5	45.5	45.5	21.5	23.0	25.5
<hr/>																		
C.D. = 383.34 C.D. = 5.17 C.D. = 13.35 C.D. = 15.33 C.D. = 19.52 C.D. = 12.75																		
<u>6 hrs treatment</u> <u>6 hrs treatment</u> <u>6 hrs treatment</u> <u>6 hrs treatment</u> <u>6 hrs treatment</u> <u>6 hrs treatment</u>																		
Diff. 1%W -C = 475 Diff. 1%W -C = 4.5 Diff. 1% W-C = 2.5 Diff. 1% W-C = 2.5 Diff. 1% W-C = 5.5 Diff. 1% W-C = 8.5																		
1% EW-C = 755 Diff. 1%EW-C = 6.5 Diff. 1%EW-C = 13 Diff. 1%EW-C = 18 Diff. 1%EW-C = 15.5 Diff. 1%EW-C = 14																		
Statistical																		
Analysis	<u>12 hrs treatment</u> <u>12 hrs treatment</u> <u>12 hrs treatment</u> <u>12 hrs treatment</u> <u>12 hrs treatment</u> <u>12 hrs treatment</u>																	
	Diff. 1% W-C = 630.6 Diff. 1% W-C = 1.5 Diff. 1% W-C = 0 Diff. 1% W-C = 6 Diff. 1% W-C = 0 Diff. 1% W-C = 1.5																	
	Diff. 1%EW-C = 602 Diff. 1%EW-C = 2.5 Diff. 1%EW-C = 2.7 Diff. 1%EW-C = 9.5 Diff. 1%EW-C = 0 Diff. 1%EW-C = 4																	

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

PHOTO - 17: EFFECT OF 12 HRS. TREATMENT WITH EXTRACTS OF *Spirodella polyrhiza* ON MAIZE (R-49) STEM.



Control



1 % ETHER WATER-EXTRACT

Statistical analysis of data shows that effect of 1 percent water and ether extract for 6 hrs pre-soaking treatments are significant at 5 percent error probability.

Effect on Diameter of Xylem :

Observations given in Table-30 and Photo-17 show that diameter of xylem uneffected with 1 percent water extract in 12 hrs treatment. However, there is an increase with 1 percent ether extract. Observed increase with 1 percent ether extract in 6 and 12 hrs is to the similar extent.

Observed effect has been found statistically insignificant at 5 percent error probability.

Effect on Diameter of Phloem :

Results given in Table-30 and Photo-17 indicate that effect of 1 percent water and 1 percent ether extract increase both under 6 and 12 hrs treatments. However, while effect of 1 percent ether extract is maximum in effectiveness in 6 hrs treatment.

Statistical analysis suggests that observed increase with 6 hrs treatment and 1 percent ether extract is significant at 5 percent error probability.

Effect on Diameter of Tracheids :

A perusal of Table-30 and Photo-17 show some kind of variance with normal trend of effect, while effect of 6 hrs treatment marks maximum increase with 1 percent ether extract on diameter of metaxylem, 12 hrs treatment exercises no effect with 1 percent water and ether extracts. In case of protoxylem diameter, effect of 1 percent ether extract is more pronounced than its counterpart water extract. But effect of 1 percent ether extract and 6 hrs treatment is maximum.

Statistical analysis of data shows that observed effects on protoxylem, 6 hrs and 1 percent water and ether extracts are significant. Effects on metaxylem are insignificant at 5 percent error probability.

INFLUENCE OF 6 HRS PRE-SOAKING ON STOMATAL AND EPIDERMAL DEVELOPMENT :

Effect on Number of Stomata :

Influence of pre-soaking seed treatment with *S. polyrhiza* extracts on number of stomata has been recorded in Table-31. A perusal of data shows that different concentrations of water and ether extracts (0.5, 1, 2 and 5 percent) exercise a sustained beneficial effect. Effect of ether extract is more pronounced. Maximum number of stomata has been observed with 1 percent water and ether extract on both upper and lower epidermis of leaves. A gradual decline in number of stomata was observed with corresponding increase or decrease in concentration of extracts applied.

Statistical analysis of data shows that observed increase in number of stomata with 1 percent water and ether extracts for both upper and lower epidermis are significant at 5 percent error probability.

Effect on Perimeter of Single Stomatal Opening :

Results given in Table-31 shows that treatment with different concentrations of (0.5, 1, 2 and 5 percent) extracts bring about an increase in perimeter to an appreciable extent. However, effect of ether extract is more pronounced. Maximum

TABLE - 31 :

RESPONSE OF EPIDERMIS OF MAIZE (R-49) LEAVES TO 6 HRS. PRE-SOAKING SEED TREATMENT WITH
Spirodella polyrhiza EXTRACTS (AVERAGE OF 25 REPLICATES)

KIND OF EXTRACT	SURFACE	NUMBER OF STOMATA PER MICROSCOPIC FIELD of 1984 S.q. μ					PERIMETER OF SINGLE STOMATAL OPENING IN μ					NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD OF 1984 S.q. μ					LENGTH OF EPIDERMAL CELLS IN μ					BREADTH OF EPIDERMAL CELLS IN μ				
		C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
Water Extract	Upper	5.0	5.2	5.8	5.4	5.0	72.1	75.0	84.9	78.1	76.5	39.6	37.2	27.6	27.9	27.1	104.8	123.6	117.3	102.3	116.2	21.2	23.1	29.2	31.2	24.4
	Lower	5.3	6.7	7.8	6.2	5.1	75.8	80.9	91.6	90.2	84.2	40.1	27.9	33.2	26.4	28.2	130.1	137.4	154.4	138.9	142.7	16.6	23.1	21.1	23.3	20.6
Ether Extract	Upper	5.0	5.8	8.8	6.8	5.7	72.1	76.6	90.2	83.6	78.7	39.6	40.2	33.3	30.6	35.3	104.8	91.2	126.8	108.2	120.38	21.2	23.1	17.8	25.1	21.2
	Lower	5.3	6.5	8.9	6.7	6.6	75.8	82.4	101.0	93.6	87.3	40.1	32.3	29.2	37.2	38.4	130.1	99.9	141.3	134.3	132.6	16.6	26.2	20.1	17.4	22.5

C.D. = 0.82

Upper surface

Diff. 1%W -C = 0.8

Diff. 1% EW-C = 3.8

C.D. = 3.30

Upper surface

Diff. 1%W -C = 12.8

Diff. 1%EW-C = 18.1

C.D. = 5.43

Upper surface

Diff. C-0.5% W = 2.4

Diff. 0.5%EW-C = 0.6

C.D. = 13.99

Upper surface

Diff. 0.5% W-C = 18.8

Diff. 1%EW-C = 22.0

C.D. = 4.35

Upper surface

Diff. 2% W-C = 10.0

Diff. 2%EW-C = 3.9

Statistical

Analysis

Lower surface

Diff. 1%W -C = 2.5

Diff. 1% EW-C = 3.6

Lower surface

Diff. 1%W -C = 15.8

Diff. 1%EW-C = 25.6

Lower surface

Diff. C-1% W = 6.9

Diff. C-5%EW-C = 1.7

Lower surface

Diff. 1% W-C = 24.3

Diff. 1%EW-C = 11.2

Lower surface

Diff. 2% W-C = 6.7

Diff. 0.5%EW-C = 9.6

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

increase in perimeter of stomatal opening has been observed in 1 percent treatment with water and ether extracts on both upper and lower epidermis. Lowering or increase in concentration results a declining effect of extracts.

Statistical analysis of data suggests that observed increase in perimeter of stomatal opening with 1 percent water and ether extracts on both upper and lower epidermis are found to be significant at 5 percent error probability.

Effect on Number of Epidermal Cells :

A perusal of Table-31 shows that effect of treatment with *S. polyrhiza* extracts on number of epidermal cells is inconsistent and there is no regular pattern of effect with increase or decrease in concentrations of extract applied. However, water extract marks maximum number of epidermal cells in 0.5 and 1 percent respectively on upper and lower epidermis. Likewise ether extract shows maximum number of epidermal cells with 0.5 and 5 percent on upper and lower epidermis respectively. In case of ether extract on upper epidermis only numbers are more than control.

Statistical analysis of results shows that observed effect is significant only in case of 1 percent water extract on lower epidermis at 5 percent error probability.

Effect on Length of Epidermal Cells :

Observations given in Table-31 shows that 0.5 and 1 percent water extract on upper and lower epidermis respectively, and 1 percent ether extract on both upper and lower epidermis exercise maximum increases in length of epidermal cells. Maximum length of epidermal cells has been observed with 1 percent water extract on lower epidermis. Trend of results on effect of different concentrations is inconsistent.

Statistical analysis of results shows that observed increase with maximum effective concentrations are insignificant at 5 percent error probability.

Effect on Breadth of Epidermal Cells :

A perusal of Table-31 shows that 2 percent water extract on upper and lower epidermis and 2 and 0.5 percent ether extracts on upper and lower epidermis respectively exercise maximum increase in breadth of epidermal cells. Maximum breadth of epidermal cells have been observed with 2 percent water extract on upper epidermis. Trend of results on effect of different concentrations are inconsistent.

Statistical analysis of data show 2 percent water extract on upper and lower epidermis and 0.5 percent ether extract on lower epidermes has been found to be statistically

significant at 5 percent error probability.

INFLUENCE OF 12 HRS PRE-SOAKING ON STOMATAL AND EPIDERMAL DEVELOPMENT :

Effect on Number of Stomata :

Influence of pre-soaking seed treatment with *S. polyrhiza* extracts on number of stomata has been recorded in Table-32 and Photo-18, 19. A perusal of data shows that different concentrations of water and ether extracts (0.5, 1, 2 and 5 percent) exercise a sustained beneficial effect. Effect of ether extract is more pronounced. Maximum number of stomata has been observed with 1 percent water and ether extract on both upper and lower epidermis of leaves. A gradual decline in number of stomata was observed with corresponding increase or decrease in concentration of extracts applied.

Statistical analysis of results show that observed increase in number of stomata with 1 percent water and ether extracts for both upper and lower epidermis are significant at 5 percent error probability.

Effect on Perimeter of Single Stomatal Opening :

Results given in Table-32 and Photo-18, 19 show that treatment with different concentrations of (0.5, 1, 2 and 5 percent) extracts bring about an increase in perimeter to an

TABLE - 32 :

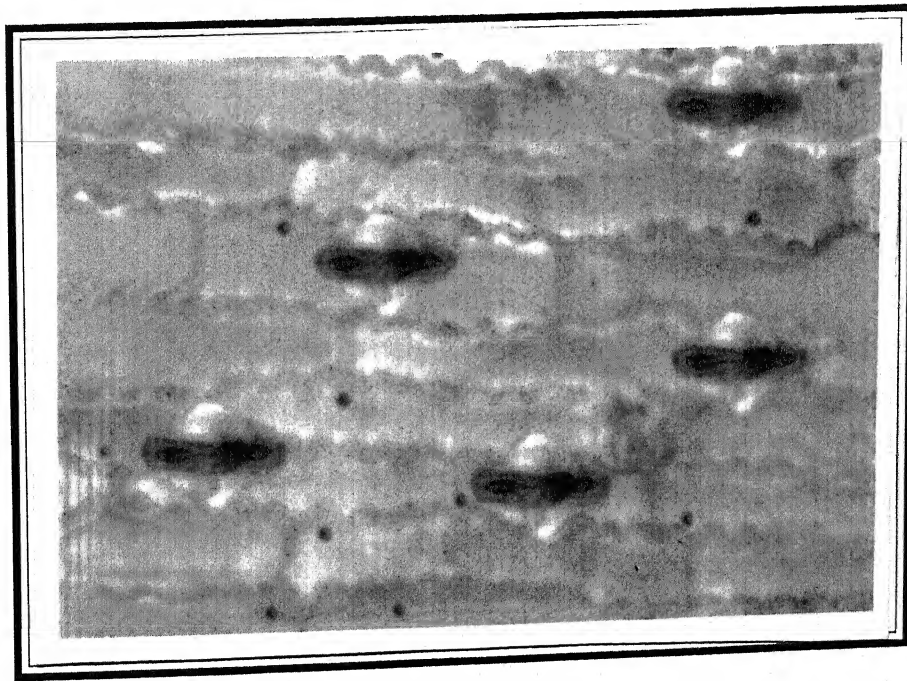
RESPONSE OF EPIDERMIS OF MAIZE (R-49) LEAVES TO 12 HRS PRE-SOAKING SEED TREATMENT WITH
Spirodella polyrhiza EXTRACT (AVERAGE OF 25 REPLICATES)

KIND OF EXTRACT	SURFACE	NUMBER OF STOMATA PER MICROSCOPIC FIELD OF 1984 S.q. μ			PERIMETER OF SINGLE STOMATAL OPENING IN μ			NUMBER OF EPIDERMAL CELLS PER MICROSCOPIC FIELD OF 1984 S.q. μ			LENGTH OF EPIDERMAL CELLS IN μ			BREADTH OF EPIDERMAL CELLS IN μ		
		C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%	C	0.5%	1%	2%	5%
Water Extract	Upper	7.0	8.0	8.2	5.7	5.4	82.5	85.0	94.1	84.1	78.5	32.3	31.3	33.0	32.9	34.0
	Lower	7.4	8.6	9.1	5.9	5.7	86.5	84.5	99.2	91.1	82.1	32.0	30.2	35.1	38.0	36.3
Ether Extract	Upper	7.0	8.0	9.2	6.2	5.7	82.5	82.5	103.0	94.2	82.0	32.3	32.2	32.2	30.0	34.5
	Lower	7.4	8.8	9.8	7.4	6.5	86.5	91.2	110.6	96.6	87.4	32.0	33.6	33.3	30.3	30.0
		C.D. = 0.42			C.D. = 3.89			C.D. = 16.71			C.D. = 19.53			C.D. = 7.07		
		<u>Upper surface</u>			<u>Upper surface</u>			<u>Upper surface</u>			<u>Upper surface</u>			<u>Upper surface</u>		
		Diff. 1%W -C = 1.2			Diff. 1%W -C = 11.6			Diff. 5% W-C = 1.7			Diff. C-1% W = 35.8			Diff. 5% W-C = 17.5		
		Diff. 1% EW-C = 2.2			Diff. 1%EW-C = 20.5			Diff. 5%EW-C = 2.2			Diff. C-1%EW = 11.9			Diff. 2%EW-C = 17.5		
		<u>Lower surface</u>			<u>Lower surface</u>			<u>Lower surface</u>			<u>Lower surface</u>			<u>Lower surface</u>		
		Diff. 1%W -C = 1.7			Diff. 1%W -C = 12.7			Diff. 2% W-C = 6.0			Diff. 0.5% W-C = 6.1			Diff. 5% W-C = 6.6		
		Diff. 1% EW-C = 2.4			Diff. 1%EW-C = 24.1			Diff. 0.5%EW-C = 1.6			Diff. 2%EW-C = 17.9			Diff. 1%EW-C = 1.0		

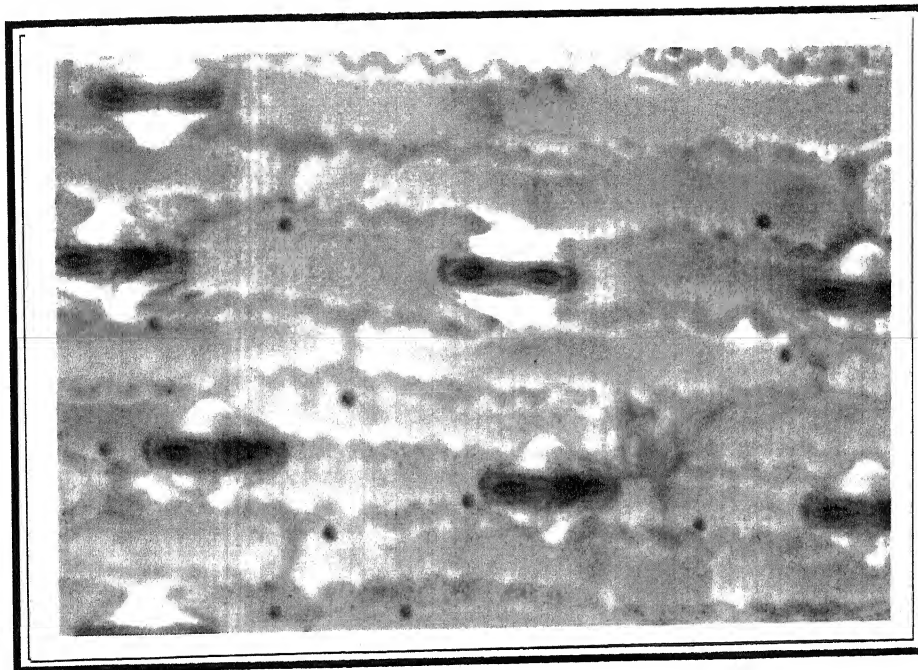
Statistical Analysis

ABBREVIATIONS USED : C = Control, W = Water extract, EW = Ether-Water extract, C.D. = Critical Difference.

PHOTO - 18: EFFECT OF 12 HRS. TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON UPPER EPIDERMIS OF MAIZE (R-49) LEAF.

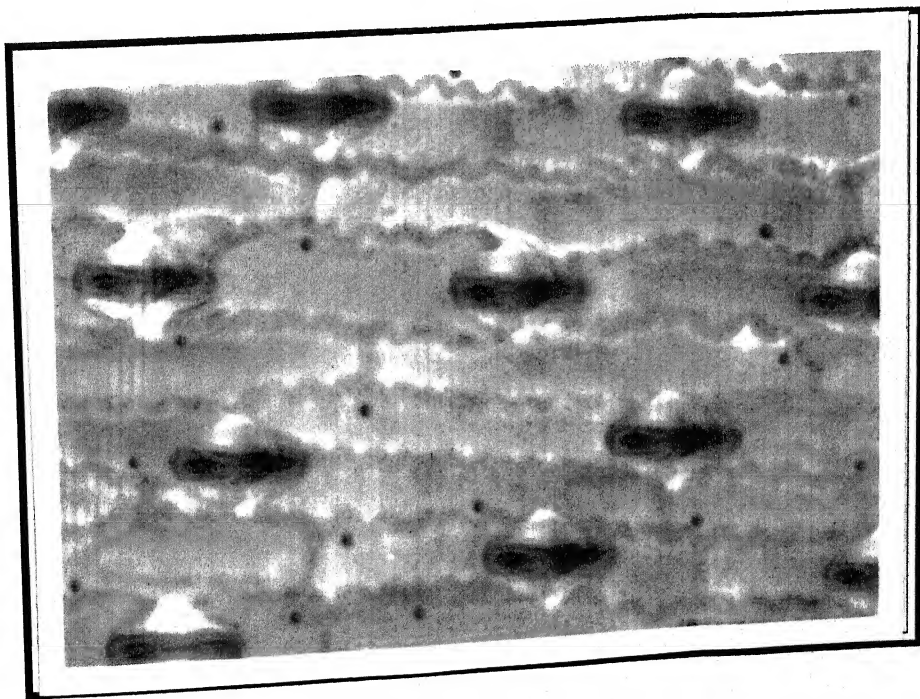


Control

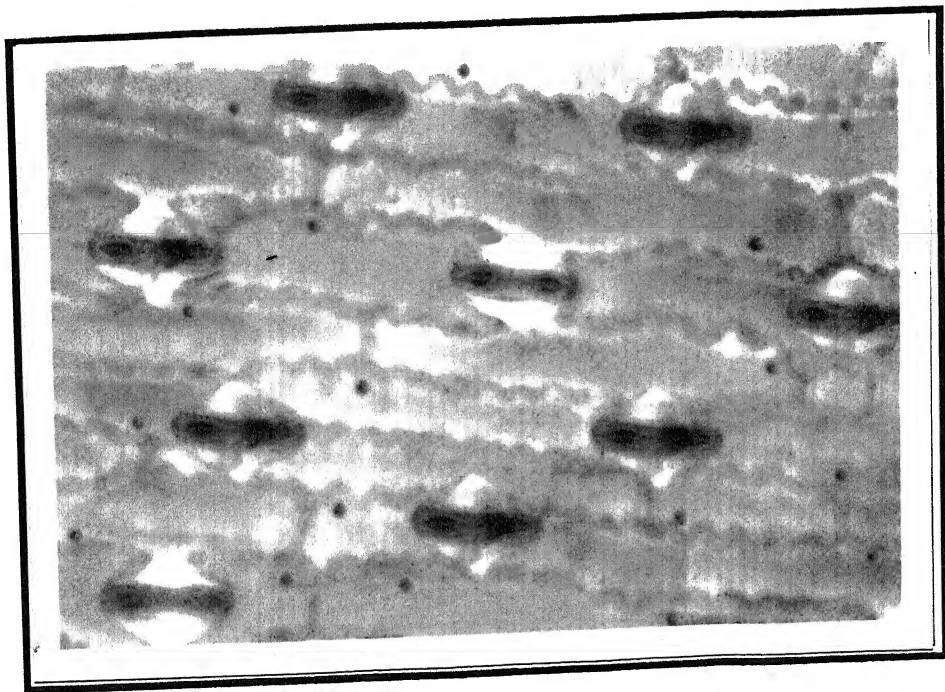


1 % ETHER WATER-EXTRACT

PHOTO - 19: EFFECT OF 12 HRS. TREATMENT WITH *Spirodella polyrhiza* EXTRACTS ON LOWER EPIDERMIS OF MAIZE (R-49) LEAF.



Control



1 % ETHER WATER-EXTRACT

appreciable extent. However, effect of ether extract is more pronounced. Maximum increase in perimeter of stomatal opening has been observed in 1 percent treatment with water and ether extracts on both upper and lower epidermis. Lowering or increase in concentrations result a declining effect of extracts.

Statistical analysis of data suggests that observed increases in perimeter of stomata with 1 percent water and ether extracts on both upper and lower epidermis are found to be significant at 5 percent error probability.

Effect on Number of Epidermal Cells :

Observations given in Table-32 and Photo-18, 19 show that 5 and 2 percent water extract on upper and lower epidermis respectively, and 5 and 0.5 percent ether extract on both upper and lower epidermis exercises maximum increase in number of epidermal cells per unit area. Maximum number of epidermal cells has been observed with 2 percent water extract on lower epidermis. Trend of results on effect of different concentrations is inconsistent.

Statistical analysis of results shows that observed increase with maximum effective concentrations are insignificant at 5 percent error probability.

Effect on Length of Epidermal Cells :

A perusal of Table-32 and Photo-18, 19 show that effect of treatment with *S. polyrhiza* extracts on length of epidermal cells is inconsistent and there is no regular pattern of effect with increase or decrease in concentrations of extract applied. However, ether extract marks maximum length of epidermal cells in 1 and 2 percent respectively on upper and lower epidermis. Likewise water extract shows maximum length of epidermal cells with 1 and 0.5 percent on upper and lower epidermis respectively. In case of water and ether extracts on lower epidermis length of epidermal cells is more than control.

Statistical analysis of results shows that observed effect is significant only in case of 1 percent water extract on upper epidermis at 5 percent error probability.

Effect on Breadth of Epidermal Cells :

Observation given in Table-32 and Photo-18, 19 show that 5 percent water extract on upper and lower epidermis and 2 and 1 percent ether extract on upper and lower epidermis respectively exercises maximum increase in breadth of epidermal cells. Maximum breadth of epidermal cells has been observed with 2 percent ether extract on upper epidermis. Trend of

results on effect of different concentrations are inconsistent.

Statistical analysis of results show that observed increases with 5 percent water extract and 2 percent ether extract on upper epidermis are significant at 5 percent error probability.

DISCUSSION

DISCUSSION

Literature concerned with aquatic vegetation (Bhambie, 1966; Shukla, Pandey and Shukla, 1973; Shukla and Pandey 1979; Pandey, 1979) emphasized interesting facts and provided new dimension of importance to major noxious aquatic weeds. The topic has been extensively reviewed by Arber (1920), Hillman (1961), Subramanyam (1962), King (1966), Varshney (1973) and Varshney and Singh (1973). Perimeters of study defined for present study, brought to knowledge facts of both academic and applied significance.

Spirodella polyrhiza plants comprise one of the major noxious weeds and exhibit vast infestation throughout India. Interestingly, in Banda the species has been found growing in association with other lemroids (Tripathi and Awasthi, 2001). Detailed information about lemroid infestations and their importance in multiple ways have been recorded earlier (Guppy, 1894; Hicks, 1937; Luther, 1951; Pandey, 1979; Awasthi and Shukla, 1986). The topic has been dealt in some detail by Arber (1920), Landolt (1957) and Pandey (1979). The broader concepts are based on information on lemroids like *Lemna minor*, *L. valoisiana*, *L. trisulca*, *L. gibba*, *L. perpusilla*, *Wolffia punctata* and *Wolffiella linguata*. There are also

causal reports about *S. polyrhiza's* response to temperature. As referred to earlier, growth of lemroids in Banda has been obtained in slightly moving or stagnant waters of small ponds, ditches, drainage channels or sewage outlets rich in organic matter. Lemroids may continue to grow out of water even on wet mud (McClay, 1974).

Based on information scattered in the literature and preliminary observation made (Shukla, Pandey and Shukla, 1973, Shukla and Pandey, 1979; Tripathi and Awasthi, 2001) perimeters of study setup for present investigation, more fruits, revealed interesting results and provided a new dimension of importance to *S. polyrhiza*. Present investigation has brought to knowledge, fact of both academic and applied significance. The utility of *S. polyrhiza* for obtaining extracts to be employed in agriculture has further vandedicated importance of lemroids. A correlative discussion of observations made during present investigation and facts recorded elsewhere in the literature would provide a conceptual synthesis of the subject matter.

The natural history and geographical distribution of duckweeds is suggestive of their global occurrence. About half of the total number of the species of the family Lemnaceae are basically tropical or sub-tropical but rest of them are

distinctly temperate. *Spirodella polyrhiza*, *Lemna gibba*, *L. minor*, *L. perpusilla* and *L. trisulca* appear worldwide in distribution, the last of them only confined to cold climatic areas. There are also reports of other lemnaid species from South America (Koch, 1932) and Australian species from Missouri (Saeger, 1934). The known cosmopolitan lemnoids are conspicuously absent in certain localities. The aforesaid distribution is suggestive of the fact that further investigations might be either influx of lemnoids in certain localities as a result of their migration from else where or their disappearance. Survey reports on estimated trends of duckweed infestations are also suggestive of their increase, decrease or constant growth in India (Varshney and Singh, 1973). Such observations have also remained tangible during earlier investigations and out of various cosmopolitan lemnoids referred to earlier, *Lemna paucicostata*, *Spirodella polyrhiza* and *Wolffia arrhiza* only could be recorded from habitats of Kanpur (Pandey, 1979) and Banda (Tripathi and Awasthi, 2001). This emphasizes that perhaps dynamic features of habitats are closely linked with duckweed infestations.

The range of pH of water between 6.5 to 7.5, a varied sunlight to dense shade and temperature of 20 to 30°C support *S. Polyrhiza* in Banda. Habitats and ecological conditions prevailing in Banda supporting the duckweed growth fit in

general within broad ambit of variance of environmental perimeters reported elsewhere for growth of lemnoids (Hillman, 1961). It is interesting to note that out of 20-30 lemnoid species (Hillman, 1961) only three of them *S. polyrhiza*, *L. paucicostata* and *W. arrhiza* could be recorded from Banda. Notably it becomes apparent that light intensities, temperature range and nutritional backdrop of aquatic environment may only be conducive to growth of hitherto, referred species or the area still awaits invasion and migration of other species from localities elsewhere.

There is evidence of extensive use of lemnoids as experimental material and primary work of Ashby (1929), Clark (1932) and Saeger (1925) on mineral nutrition and "auximone" aspects are fundamental. Their work has been reviewed by Hillman (1961).

Based on these facts the medium devised by Pandey (1979) was selected for mass culture of *S. Polyrhiza* used as material to obtain extracts of the lemnoid for conducting detailed experimental work. This medium contained K-2mg., Ca-4mg., Mg-2mg., P-2mg., S-2mg., N-6mg., Fe-5.6 ppm, Mn-0.23 ppm, Cu-0.32 ppm, Zn-0.032 ppm, Mo-0.025ppm, B-0.185 ppm Co-0.003 ppm and Ni-0.003 ppm (strength per litre). The cultures were grown under normal sun light in room temperature.

It was found that organic substances are not required for prolonged growth of lemroids (*Lemna paucicostata* and *Spirodella polyrhiza*). The fact is of considerable significance for developing *in vitro* culture technique of the lemnoïd under room temperature in tropical countries where addition of organic substances like sugars, coconut milk etc. is likely to set in fermentation of medium, thereby obstructing aseptic growth of lemroids (Pandey, 1979).

Existence of growth promoting substances in various plants has been known and their extraction for utilization in agriculture has also been emphasized in the literature. In addition to fungi and bacteria, a number of higher plants have been reported to contain gibberellins (Katzenelson, Sirosis and Cole, 1962; Brian, Hemming and Lowe, 1964; Maheshwari and Bhatia, 1966; Jones and Lang, 1968; Proanao and Greene, 1968; Hayashi, Natto, Bukovac and Sell, 1968; Iwahori, Weaver and Pool, 1968) Gibberellins have been reported from some marine algae (Mowat, 1963; 1964; 1956; Jennings and McComb, 1867; Jennings, 1968). Likewise gibberellin like substances have also been reported in extracts of *Phormidium foveolarum* (Gupta and Shukla, 1967; Gupta and Agarwal, 1973) and developing water-melon seeds (Bhalla, 1971). Growth promoting substances have also been reported in root extracts of water

hyacinth (Sircar and Kundu, 1960). There is evidence of endogenous gibberellins in floating plants and turions of *Wolffiella floribanda* (Pieterse, Bhalla and Sabharwal, 1971); *Pistia Stratiotes* plants (Maurya, 1983) and *Wolffia arrhiza* (Awasthi, 1986).

Exhaustive literature on utilization of algal extracts of *Phormidium foveolarum* in agriculture of rice (Gupta and Shukla, 1964; 1967; 1969; Shukla and Gupta, 1967; Shukla, 1968 and 1975a), wheat (Kushwaha and Gupta, 1970a, 1970b; Shukla, 1975a), *Vigna catjang* (Gupta and Gupta, 1970; 1972) 1973) and *Phaseolus aureus* (Gupta and Gupta, 1972) is available. Reports emphasized utilisation of algal extracts to boost rice growth and productivity rich in protein (Shukla, 1972), Effect of water hyacinth root extracts on rice growth and productivity has also been reported (Sircar, 1963). Influence of manuring and spraying with plant material and extracts of *S. polyrhiza* respectively on *Hordeum vulgare* have been also explored (Pandey, 1979). Present investigation revealed significant effects of *S. polyrhiza* extracts on growth, yield and certain plant constituents like nitrogen, protein, phosphorus, potassium and morpho-anatomical response of maize plants.

Results of present investigation show that there is a marked influence of extracts of *S. polyrhiza* plants on growth,

development and yield of maize plants. The results are in agreement with Sircar (1963) who has similarly reported stimulated growth of rice following treatments with root extracts of water-hyacinth, Pandey (1979) on *Hordeum vulgare* under influence of *S. polyrhiza* extracts, and Maurya (1983) on wheat with application of *P. stratiotes* extracts and Awasthi (1986) on wheat with application of *W. arrhiza* extracts.

During present investigation extraction of plant material for pre-soaking seed treatment was made in water and ether extracts suspended in water. It was observed that the latter possess more stimulatory effect. Stimulatory effect with *S. polyrhiza* extracts also depends upon soaking period. Obviously 12 hrs soaking imparted better results as compared to 6 hrs treatment.

Observations on juvenile seedling growth of maize plants show that out of various concentrations (0.5, 1, 2 and 5 percent) of extracts tried, 5 percent in variety AZAD UTTAM and 1 percent extract in R-49 exhibits alround maximum beneficial growth. Length of main root, length of lateral roots, number of lateral roots, length of shoot and number of leaves exhibit marked increase with 5 percent in variety AZAD UTTAM and with 1 percent extract in R-49. Improved seedling growth is proven with prospects of better crop.

Observations suggest that effect of water and ether extracts for 6 and 12 hrs exercise initial percentage increase at 48 hrs to larger extent but with passage of time, the effect begins to mark a decline. This fact is proven with possibility that for a sustained effect the treatment needs to be repeated periodically.

Results show that in case of maize variety AZAD UTTAM, 192 hrs old seedlings under 6 hrs pre-soaking seed treatments with water extract exercised 11.22, 5.79, 35.29, 20.83 and 42.85 percent increase on length of main root, length of lateral roots, number of lateral roots length of shoot and number of leaves respectively and 17.17, 29.41, 35.29, 16.00 and 42.85 percent on length of main root, length of lateral roots, number of lateral roots, length of shoot and number of leaves respectively in ether extract. Effect of 12 hrs treatment increased, 13.18, 14.51, 28.12, 15.00 and 30.43 percent in length of main root, length of lateral root, number of lateral root, length of shoot and number of leaves respectively. In case of water extract and 7.86, 17.24, 33.33, 66.66. and 33.33 percent on length of main root, length of lateral root, number of lateral roots, length of shoot and number of leaves respectively in ether extract.

Results show that in case of maize variety R-49, 192 hrs

old seedlings with 6 hrs pre-soaking seed treatments with water extract exercised 7.54, 5.20, 11.36, 18.75 and 15.38 percent increase on length of main root, length of lateral root, number of lateral root, length of shoot and number of leaves respectively and 17.59, 10.10, 9.09, 37.14 and 16.00 percent on length of main root, length of lateral roots, number of lateral roots, length of shoot and number of leaves respectively in ether extract. Effect of 12 hrs treatment increased 11.2, 30.92, 29.03, 43.47 and 56.09 percent in length of main root, length of lateral roots, number of lateral roots, length of shoot and number of leaves respectively in case of water extract and 7.75, 30.30, 0.83, 43.47 and 24.13 percent on length of main root, length of lateral roots, number of lateral roots, length of shoot and number of leaves respectively in ether extract.

Results on effects of *S. polyrhiza* extracts on mature maize plants have also shown promising results. 5 percent extracts on variety AZAD UTTAM and 1 percent on variety R-49 exercised increase in height¹ of plants, number of leaves, length of leaves and breadth of leaves. Treated plants were more livelier and intensely green.

Maize variety AZAD UTTAM showed increase of 7.43, 6.61, 7.31, 11.11 percent in height of plants, number of leaves,

length of leaves and breadth of leaves respectively under influence of 6 hrs water extract treatment and 10.35, 9.91, 16.55 and 12.96 percent in height of plants, number of leaves, length of leaves and breadth of leaves respectively with 6 hrs ether extract. Under influence of 12 hrs water extract 2.01, 6.95, 1.00 and 14.70 percent in height of plants, number of leaves, length of leaves and breadth of leaves respectively has been increased and 10.63, 13.91, 5.03, 10.29 percent in height of plants, number of leaves, length of leaves and breadth of leaves respectively with 12 hrs ether extract.

Maize variety R-49 showed increase of 13.41, 9.09, 16.88 and 24.56 percent in height of plants, number of leaves, length of leaves and breadth of leaves respectively under influence of 6 hrs water extract treatment 57.92, 19.09, 28.46 and 54.38 percent in height of plants, number of leaves, length of leaves and breadth of leaves respectively with 6 hrs ether extract treatment, 4.52, 8.94, 1.10 and 5 percent in height of plants, number of leaves and breadth respectively under influence of 12 hrs water extract treatment, and 7.90, 9.75, 6.16 and 1.25 percent in height of plants, number of leaves, length of leaves and breadth of leaves respectively with 12 hrs ether extract.

Data on crop productivity shows that fresh vegetative weight of foliage per plant, fresh weight of male inflorescence

per plant, number of floral branches per male inflorescence, number of fruits per plant, fresh weight of fruits per plant, fresh weight of single fruit with leafy coverings, fresh weight of single fruit without leafy coverings, fresh weight of vegetative foliage per plant, dry weight of male inflorescence per plant, dry weight of 1000 seeds, dry weight of fruits per plant and yield per hectare is higher in plants treated with 5 percent in variety AZAD UTTAM and in variety R-49 1 percent extracts of *S. polyrhiza*.

Results show that in case of maize variety AZAD UTTAM with 6 hrs pre-soaking seed treatment with water extract exercised 2.54, 8.33, 6.16, 4.06, 1.76, 4.09, 6.28 percent in fresh weight of vegetative foliage per plant, number of floral branches, number of fruits per plant, fresh weight of fruit per plant, fresh weight of single fruit, fresh weight of fruit without leafy coverings and fresh weight of leafy coverings respectively, 12.34, 22.5, 4.74, 3.5 and 4.48 percent in dry weight of vegetative foliage per plant, dry weight of male inflorescence per plant, dry weight of 1000 seeds, dry weight of fruits 13.33 per plant and yield per hectare respectively in water extract treatment 5.45, 1.6, 2.5, 1.26, 8.66, 9.16 9.14 percent in fresh weight of vegetative foliage per plant, number of floral branches, number of fruits per plant, fresh weight of fruits

per plant, fresh weight of single fruit, fresh weight of fruit without leafy coverings and fresh weight of leafy coverings respectively in ether extract treatment and 22.22, 24.0, 11.90, 14.3 and 14.41 percent in dry weight of vegetative foliage per plant, number of floral branches, number of fruits per plant, fresh weight of fruits per plant, fresh weight of single fruit, fresh weight of fruit without leafy coverings and fresh weight of leafy coverings respectively in ether extract treatment and 22.22, 25.0, 11.90, 14.3 and 14.41 percent in dry weight of vegetative foliage per plant, dry weight of male inflorescence per plant, dry weight of 1000 seeds, dry weight of fruits per plant and yield per hectare respectively in ether treatment. 12 hrs treatment increased 6.78, 1.63, 15.38, 6.25, 5.88, 11.111, 5.40, 3.24 and 5.91 percent in fresh weight of vegetative foliage per plant, fresh weight of male inflorescence per plant, number of floral branches, number of fruits per plant fresh weight of fruits per plant, fresh weight of single fruit, fresh weight of single fruit without leafy coverings and fresh weight of leafy coverings respectively with water extract and 1.98, 9.89, 4.44, 7.36 and 6.77 percent in dry weight of vegetative foliage per plant, dry weight of male inflorescence per plant, dry weight of 1000 seeds, dry weight of fruits per plant and yield per hectare respectively with water extract, 7.85, 4.91, 30.76, 18.75, 12.5, 18.06, 8.29, 7.91 and 11.82 fresh

weight of vegetative foliage per plant, fresh weight of male inflorescence per plant, number of floral branches, number of fruits per plant, fresh weight of fruits per plant, fresh weight of single fruit, fresh weight of single fruit without leafy coverings and fresh weight of leafy coverings respectively with ether extract treatment, and 3.96, 12.08, 8.88, 15.89 and 18.89 and 18.87 percent dry weight of vegetative foliage per plant, dry weight of male inflorescence per plant, dry weight of 1000 seeds, dry weight of fruits per plant and yield per hectare respectively with ether extract treatment.

Maize variety R-49 showed increases with 6 hrs pre-soaking seed treatment with water extract to the extent of 35.85, 13.33, 12.5, 40.0 48.24, 30.5, 26.88, 5.0 percent in fresh weight of vegetative foliage per plant, number of floral branches, number of fruits per plant, fresh weight of fruits per plant, fresh weight of single fruit, fresh weight of single fruit without leafy coverings and fresh weight of leafy coverings respectively, 11.25, 13.33, 8.71, 57.92 and 46.56 percent in dry weight of vegetative foliage per plant, dry weight of 1000 seeds, dry weight of fruit per plant and yield per hectare with water extract 77.43, 13.12, 45.00, 75.18, 45.52, 48.82, 17.67 percent in fresh weight of vegetative foliage per plant, fresh weight of male inflorescence per plant, number of floral branches, number of fruits per plant, fresh

weight of fruits per plant, fresh weight of single fruits, fresh weight of single fruit without leafy coverings and fresh weight of leafy coverings respectively with ether extract and 26.25, 30.0, 13.84, 97.61, 80.29 percent in dry weight of vegetative foliage per plant, dry weight of male inflorescence per plant, dry weight of 1000 seeds, dry weight of fruit per plant and yield per hectare respectively with ether extract treatment. 12 hrs treatment increased 2.96, 38.09, 54.02, 32.29, 38.92 and 5.82 percent in fresh weight of vegetative foliage per plant, dry weight of male inflorescence per plant, dry weight of 1000 seeds, dry weight of fruits per plant and yield per hectare respectively with ether extract treatment. 12 hrs treatment increased 2.96, 38.09, 54.02, 32.29 percent in fresh weight of vegetative foliage per plant, number of floral branches, number of fruits per plant, fresh weight of fruits per plant, fresh weight of single fruit, fresh weight of single fruit without leafy coverings and fresh weight of leafy coverings respectively with 3.96, 22.5, 10.44, 50.75, 45.45 percent in dry weight of 1000 seeds, dry weight of fruit per plant and yield per hectare respectively with water extract treatment, and 31.11, 15.38, 23.52, 42.85, 74.34, 42.23, 44.87, 19.04 percent in fresh weight of vegetative foliage per plant, fresh weight of male inflorescence per plant, number of floral branches, number of fruits per plant, fresh weight of fruits per plant, fresh weight of single

fruit, fresh weight of single fruit without leafy coverings and fresh weight of leafy coverings respectively with ether extract and 7.92, 24, 15.42, 85.24, 78.18 percent on dry weight of vegetative foliage per plant, dry weight of male inflorescence per plant, dry weight of 1000 seeds, dry weight of fruits per plant and yield per hectare respectively with ether extract treatment. With *S. polyrhiza* extracts induce earlier fruit setting in maize plants and time required for fruits maturation is also shortened. Effect of 5 percent ether extract is more pronounced than 5 percent water extract. Variance in soaking period for 6 and 12 hrs does not show any change in fruit maturation and fruit setting except causing slight alteration in case of 5 percent water extract in variety AZAD UTTAM. The other variety R-49 investigated showed identical results but for the change in concentration of extract (1 percent water and ether extracts) applied. Fruit was also earlier in 12 hrs pre-soaking seed treatment. A comparison of the two varieties study shows that variety AZAD UTTAM exhibits slightly earlier fruit setting and maturation under both normal untreated and treated conditions.

Percentage increase in time required for fruit maturation and trend of fruiting in the two varieties of maize investigated suggests that in case of both varieties 6 hrs and 12 hrs treatments have identical effect period. Ether extract required

9.09 percent while water extract required 4.54 percent less period for fruit maturity in variety Azad Uttam. Likewise variety R-49 showed shortening in fruit maturation period to the extent of 14.28 percent in ether extract and 4.76 percent in water extract. However, a comparison of percentage in shortening of fruit maturation period is more pronounced under ether extract with maximum being in variety R-49. Trend of fruiting shows that fruit setting was hastened 3.84 and 7.69 percent, and 4.0 percent respectively under water and ether extracts in variety AZAD UTTAM. In case of variety R-49 fruit setting was earlier to the extent of 1.78 and 7.14 percent in water and ether extracts under 6 hrs treatments. 12 hrs treatment was found to be effective.

When multiple effects of *S. polyrhiza* extracts containing growth promoting substances on maize plants are examined it becomes evident that concentration, kind of extract, nature of treatment and environmental conditions all play important role in the final outcome of treatment.

The physiological peculiarities of plants in general and rice in particular (Sircar, 1958) have shown different auxin levels at various sites. Auxin levels appear to control growth and developmental pattern in various parts of the plants. A high IAA content of endosperm regulates germination and

seedling growth in rice (Sircar and Das, 1954; Sircar, Das and Lahiri, 1955). Sircar and Dutta, Ray (1962) realised the significance of IAA on nitrogen metabolism of germinating seeds. Internal IAA levels has also been presumed to be linked with subsequent plant growth (Sircar and Parija, 1949, Sircar and Das, 1954). Increase in IAA level of stamens and carpels till anthesis appears to result in reproductive growth (Sircar and Chakravarti, 1957). Thus, various physiological processes of rice are known to be regulated by IAA in various organs. It has been suggested that auxin level in rice occurs in two parts. A bulk of auxin remains in inactive form of vacuoles and auxin part below suboptimal concentration is at the sites of growth to bring about stimulation. Exogenous supplies of other growth regulators, sets in a competition between native IAA and exogenous growth regulators which displaces native auxin from its natural site of action leading to higher concentration of free auxin to exercise stimulated growth (Sircar, 1958).

The application of growth substances in extracts of *S. polyrhiza* plants suggest complex relationship between internal auxin level of maize and external application of growth substances in extracts. Changed growth and yield are results of such treatments. It may be suggested that a similar auxin controlled mechanism as referred to earlier in case of rice

may be operative in maize under influence of *S. polyrhiza* extracts.

The crude fresh extract of *S. polyrhiza* plants applied to maize plants might be containing substances, interestingly, in such a mixture of substances that provide an ideal blending of growth factors which are sufficiently endowed to alter growth development and yield of maize crop.

Pre-soaking seed treatment with algal extracts of *Phaseolus foveolarum* showed considerable increase in protein contents of rice seeds (Shukla and Gupta, 1967; Shukla, 1972, 1982). The protein content of seeds showed maximum increase 1 percent ether extract suspended in water and 5 percent water extract. There is evidence that hormone application increases protein content (Sell, Luecke, Taylor and Hamner, 1949, Wort, 1949; 1951; and Dunham, 1951).

The nitrogen and protein contents of maize varieties AZAD UTTAM and R-49 showed increase of 5.8, 5.9 and 8.8, 8.5 percent respectively under 6 hrs pre-soaking with 5 percent water extract and 11.1, 11.2 and 11.7 percent respectively with 1 percent ether extract. Influence of 12 hrs pre-soaking of seed shows an increase in the percentage of nitrogen and protein upto 5.5, 5.5 and 7.3, 7.3 percentage respectively with 5 percent water extract, and 11.1, 11.1 and 10.7 16.4 percent

respectively with 1 percent ether extract. The effect of 24 hrs pre-soaking of seed shows an increase in percentage of nitrogen and protein upto 5.2, 6.1 and 7.0, 7.0 percent respectively with 5 percent water extract and 16.3, 16.3 and 21.6, 21.6 percent with 1 percent ether extract. However, nitrogen and protein contents are found in larger extent with 24 hrs pre-soaking seed treatment. Effect of ether extract as compared to water extract is more pronounced. Increase in nitrogen and protein contents are interlinked.

Potassium and phosphorus content of the maize seed showed increase of 2.3, 4.8 and 1.2 percent respectively under the influence of 6 hrs pre-soaking of seed with 5 percent water extract and 6.6, 11.5 and 7.0, 10.8 percent respectively with 1 percent ether extract. Increase in phosphorus and potassium contents up 1.6, 6.2 and 2.0, 5.6 percent respectively under influence of 12 hrs pre-soaking seed treatment with 5 percent water extract and 10.1, 12.2 and 11.0, 12.4 percent respectively with 1 percent ether extract. Increase in phosphorus and potassium contents upto 1.3, 5.4 and 2.3, 6.5 percent respectively under influence of 24 hrs pre-soaking seed treatment with 5 percent water extract and 11.7, 12.4 and 13.2, 12.9 percent respectively with 1 percent ether extract. Comparison of results of phosphorus and potassium contents of maize varieties (AZAD UTTAM) and (R-49) seeds show

significant changes. 24 hrs treatment is more effective and influence of ether extracts are comparatively more pronounced than water extract.

During present investigation *S. polyrhiza* extracts have brought about increases in nitrogen, protein, phosphorus, and potassium contents of the grain thereby adding edible value and dough quality of maize. Observed increases appear to be at the expense of other constituents of lesser commercial significance. A comparison of *L. paucicostata* and *S. polyrhiza* extracts on maize yield and quality constituents would be of interest to gauge value of agricultural adoption by growers of commercial crop. The overall effect of *S. polyrhiza* extracts is better than *Lemna paucicostata* extracts and the adoption of *Spirodella polyrhiza* extract more beneficial to boost maize productivity and improved quality of produce.

A perusal of results on the effect of *S. polyrhiza* extracts on diameter of xylem, phloem and size of tracheids shows marked alteration. A comparison of results of 6 and 12 hrs pre-soaking seed treatment on anatomy shows significant changes. 12 hrs treatment is more effective and influence of ether extracts are comparatively more pronounced than water extracts.

Results on anatomy of root show that 6 hrs treatment

with ether extract uniformly increases diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundles, size of metaxylem and number of metaxylem in both varieties of maize (AZAD UTTAM and R-49). Twelve hours treatment exercises maximum increases in diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundles, size of metaxylem and number of metaxylem with extract in both AZAD UTTAM and R-49 varieties except that in variety AZAD UTTAM diameter of root increases to the maximum extent in case of water extract.

Maize variety AZAD UTTAM showed increase of 18.81, 12.22, 24.08, 12.66, 24.75 and 25.45 percent in diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundle, size of metaxylem and number of metaxylem respectively under influence of 6 hrs water extract treatment; 20.89, 19.41, 35.77, 14.0, 33.60 and 36.36 percent in diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundle, size of metaxylem and number of metaxylem respectively with 6 hrs ether extract treatment; 14.47, 17.74, 25.92, 9.37 and 42.98, 5.12 percent in diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundle and size of metaxylem, number of metaxylem respectively under influence of 12 hrs water extract treatment;

and 13.15 19.77, 28.14, 11.25 and 57.01, 2.53 percent in diameter of root, diameter of stele, diameter of vascular bundle and size of metaxylem, number of metaxylem with 12 hrs ether extract treatment.

Maize variety R-49 showed increase of 14.98, 15.68, 17.0, 4.13, 22.0 and 13.84 percent in diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundle, size of metaxylem and number of metaxylem respectively under influence of 6 hrs water extract treatment, 22.68, 19.43, 24.13, 13.97, 26.66 and 30.76 percent in diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundle, size of metaxylem and number of metaxylem respectively with 6 hrs ether extract treatment; 12.27, 13.15, 14.59, 8.27, 13.86, and 6.15 percent in diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundle, size of metaxylem and number of metaxylem respectively under influence of 12 hrs water extract treatment; and 14.13 21.66, 20.54, 10.34, 18.97, 7.69 percent in diameter of root, diameter of stele, diameter of vascular bundle, number of vascular bundle, size of metaxylem and number of metaxylem respectively with 12 hrs ether extract treatment.

Anatomy of stem is also markedly influenced by *S.*

polyrhiza extracts. In variety AZAD UTTAM and R-49 6 hrs treatment exercises maximum increase in diameter of stem, number of vascular bundle, diameter of phloem tissue and diameter of tracheids with ether extract as compared to water extract. 12 hrs treatment shows that ether extract induced maximum increase in number of vascular bundle, diameter of phloem tissue and diameter of tracheids with ether extract in both varieties (AZAD UTTAM and R-49) but diameter of stem increases to the maximum extent in case of water extract in variety R-49.

Results show that in case of maize variety AZAD UTTAM, water extract treatment with 6 hrs pre-soaking exercised 21.42, 3.60, 23.01, 52.63, 51.66 and 17.5 percent increase in diameter of stem, number of vascular bundle, diameter of xylem, diameter of phloem, diameter of metaxylem and diameter of protoxylem respectively and 27.10, 7.54, 30.82, 61.84, 61.66 and 40.0 percent in diameter of stem, number of vascular bundle, diameter of xylem, diameter of phloem, diameter of metaxylem and diameter of protoxylem respectively in ether extract. Effect of 12 hrs treatment increased 18.85, 3.22, 27.02 percent in diameter of stem, number of vascular bundle, diameter of xylem, diameter of phloem, diameter of metaxylem and diameter of protoxylem respectively in case of water extract; and 26.73, 8.75, 34.45, 57.5, 59.9 and 37.77 percent

in diameter of stem, number of vascular bundle, diameter of xylem, diameter of phloem, diameter of metaxylem and diameter of protoxylem respectively in case of ether extract.

Maize variety R-49 showed increase with 6 hrs pre-soaking amounting 12.71, 15.51, 2.94, 5.20, 15.94 and 50.00 percent in diameter of stem, number of vascular bundle, diameter of xylem, diameter of phloem, diameter of metaxylem and diameter of protoxylem respectively in case of water extract and 20.21, 22.41, 15.29, 37.5, 44.92 and 82.35 percent in diameter of stem, number of vascular bundle, diameter of xylem, diameter of phloem, diameter of metaxylem and diameter of protoxylem respectively in ether extract. Effect of 12 hrs treatment increased 14.83, 5.26, 11.53 and 6.97 percent in diameter of stem, number of vascular bundle, diameter of phloem and diameter of protoxylem respectively in case of water extract and 14.16, 8.77, 2.83 and 18.26, 18.60 percent in diameter of stem, number of vascular bundle, diameter of xylem, diameter of phloem and diameter of protoxylem respectively in ether extract.

In seedlings tension wood formation is induced by application of NAA (0.03-0.01 percent), 2, 4-D (0.10 percent) and IAA (0.5 percent), a strong swelling, which is the results of an acceleration in the rate of cambial division, occurs in

the stem below the treatment site.

The number of tracheary elements found in the tension wood induced by DNP in some seedlings are either equivalent or in others slightly reduced relatively to the number of tracheary elements present in the xylem formed before treatment. In the *Acer rubrum* system (Morey, 1968a; b) it is probable that the relative frequency at which tracheary elements are initiated from the fusiform initials related to the level of auxin in the cambial initiation zone. This implies that the level of auxin in the system below the DNP treatment site where tracheary elements are initiated from the divicing initials or adjacent cambial derivatives is largely unaffected by treatment with DNP. It seems inconsistent, on the other hand the capacity of DNP to induce the formation of tension wood in the same region of the stem is explained in terms of developmental response to auxin deficiency. However, the cambial derivatives undergoing secondary wall development, namely the xylem elements in the wall thickening phase of development are segregated from the cambial initials by more or less arbitrary zone of cells in which the walls are expanding by surface growth. In this regard DNP may be more effective in lowering the auxin level in the centripetal zone of the stem than in the peripheral meristematic region.

This synoptical background about development of tracheids is clearly indicative of the fact that development of xylem is linked with auxin level in both root and stem. Auxin deficiency stimulates development of xylem (Morey, 1968a; Money and Cronshaw, 1966). Exogenous supplies of certain growth substances which blocked the polar transport of auxins create deficiency of auxin in areas just above the region of blockade (Cronshaw and Morey, 1965). During present investigation exogenous supply of growth substances of extracts of *S. polyrhiza* through pre-soaking seed treatment appears to set in some kind of competition with the endogenous auxin levels and displaces auxins through polar transport to the extremities of root and stem to initiate their apical growth, and in the process create condition of auxin deficiency in the older regions of two organs, thereby stimulating development of xylem in the root and shoot. This may explain the increased formation of xylem, pholem and diameter of tracheids observed during present investigation.

Observations of epidermal cells, number of stomata and perimeter of single stomatal opening show that out of various concentrations (0.5, 1, 2 and 5 percent) of extracts tried 5 percent in variety AZAD UTTAM and 1 percent in variety R-49 exhibit maximum effectiveness. A comparison of results

of 6 and 12 hrs pre-soaking seed treatment show significant changes. 12 hrs treatments is more effective and influence of ether extracts are comparatively more pronounced than that of water extracts. Results on number of epidermal cells, and length and breadth of epidermal cells show no set pattern of effect and results obtained are inconsistent.

Results show that in case of maize variety AZAD UTTAM, the upper surface of leaves, with 6 hrs pre-soaking seed treatment with water extract exercised 16.0 and 30.59 percent increase in number of stomata and perimeter of stomatal opening respectively, and 45.09 and 47.77 percent in number of stomata and perimeter of stomatal opening respectively with ether extract. Effect of 12 hrs treatment increased 45.00 and 24.96 percent in number of stomata and perimeter of stomatal opening respectively in case of water extract, and 55.00 and 35.92 percent in number of stomata and perimeter of stomatal opening respectively with ether extract. The lower surface of leaves under 6 hrs pre-soaking seed treatments with water extract exercised 23.07 and 32.33 percent increased in number of stomata and perimeter of stomatal opening respectively, and 18.18 and 39.99 percent number of stomata and perimeter of stomatal opening respectively with ether extract. Effect of 12 hrs treatment increased 39.39 and 22.23 percent in number

of stomata and perimeter of stomatal opening respectively in case of water extract, and 43.93 and 38.92 percent in number of stomata and perimeter of stomatal opening respectively with ether extract.

Maize variety R-49 showed in upper surface of leaves under 6 hrs pre-soaking seed treatment with water extract 16.00 and 17.75 percent increase in number of stomata and perimeter of stomatal opening respectively, and 71.69 and 23.35 percent number of stomata and perimeter of stomatal opening respectively with ether extract. 12 hrs treatment increased 17.14 and 14.00 percent in number of stomata and perimeter of stomatal opening respectively in case of water extract, and 76.00 and 23.35 percent in number of stomata and perimeter of stomatal opening respectively with ether extract treatment. Pre-soaking seed treatment for 6 hrs with water extract exercised on lower surface of leaves 50.00 and 21.91 percent increase in number of stomata and perimeter of stomatal opening respectively and 67.92 and 33.24 percent in number of stomata and perimeter of stomatal opening respectively with ether extract. Effect of 12 hrs treatment showed increase of 24.28 and 17.29 percent in number of stomata and perimeter of stomatal opening respectively in case of water extract, and 32.43 and 28.52 percent in number of

stomata and perimeter of stomatal opening respectively with ether extract.

The stomata are the principle portals through which gaseous exchanges take place between the intercellular spaces and surrounding atmosphere. The efficiency of stomatal apparatus in controlling gaseous exchanges of the plants extensively studied by Brown and Escombe (1900), who have pointed out that the rate of diffusion through small opening (like stomata) in a given period of time is proportional to the perimeter and not to the area of the pore. The greater the perimeter, the more rapid is the rate of diffusion. Earlier observations of Shukla (1969) revealed that application of 1 percent hormone reduces the size of stomata in treated plants but increases their number and perimeter. Consequently, it was suggested that there would be more rapid diffusion of carbon dioxide in the leaves of treated rice plants. Similarly influence of algal extracts on stomatal and epidermal development of wheat leaves (Shukla, 1975b) and synthetic growth substances on maize leaves has been recorded earlier (Shukla and Shukla, 1975). Observed changes in stomatal and epidermal development in response to *S. polyrhiza* extracts are in agreement with earlier reports.

It may, therefore, be concluded that treated plants are

better adopted for photosynthetic activity as compared to the normal untreated plants, this may partially explain the beneficial effect of *S. polyrhiza* extract on growth of maize plants.

When effect of *S. polyrhiza* extracts on two varieties of maize is examined for its totality, results obtained suggest that ether extracts of *S. polyrhiza* impart more beneficial effect as compared to water extract. The two soaking periods of 6 and 12 hrs tried exhibit more pronounced effect except for response of variety R-49 in case of 6 hrs ether extract. Of all the treatment effects productivity of maize has witnessed a maximum boost in variety R-49 under influence of 6 hrs pre-soaking with ether of *S. polyrhiza*.

Results are suggestive of the fact kind of extract, and pre-soaking seed treatment period play a vital role towards productivity response of maize. There is also a varied response of different varieties (AZAD UTTAM and R-49) of maize to such treatments. It invites study of varied varietal response to *S. polyrhiza* extracts before they are practised for various maize varieties in agriculture.

Present findings emphasized the significance of *S. polyrhiza* infestation and how best they could be utilized for obtaining extracts which possess a tremendous capacity to boost not only juvenile seedling growth and development of maize crop but

also exercise stimulation in vegetative growth and yield of mature plants. Certain plant constituents like nitrogen, protein, phosphorous, potassium and morpho-anatomical features following such treatment are so altered that render plants better adopted for life and productivity. The treated plants are not only intensively green, livelier and with profuse development of broader and longer leaves but their stems and roots possess better conducting tissues. The stomatal and epidermal structures also acquire better adaptability for photosynthetic activity. Results presented were subjected to statistical procedures following analysis of variance method and suggest that observed effects are significant.

In view of large quantities of *S. polyrhiza* infestations and abundance of material available, prospects of its utilization as a source for obtaining extracts containing growth promoting substances for implementing boost in growth, yield and altering quality of maize crop appear promising. Results are of considerable value for growers of commercial crop of maize.

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POLLUTION RESEARCH

ENVIRO MEDIA

KERATINOPHILIC FUNGI AND DERMATOPHYTES FROM TANNERY EFFLUENT

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Key Words : Keratinophilic fungi; Dermatophytes; Tannery.

Keratinophilic fungi in India were isolated for the first time from Dibrugarh, Assam (Dey and Kakoti, 1955). Later reports of isolation of these fungi were made by various investigators (Padhye, 1961; Roy *et al.*, 1972; Saxena and Baruah, 1982; Awasthi and Shukla, 1988). No study has been made so far on occurrence of keratinophilic fungi from tannery effluent in India. Present study deals with keratinophilic fungi and dermatophytes from effluents of Kanpur tanneries in India.

Effluent samples were collected from different tanneries of Kanpur during 1991-1992. Samples were collected in sterilized polythene bags and stored in laboratory at room temperature. Isolations were made using decomposing keratinous substances like hair, feathers and nails. Ten to fifteen mls of effluent from each sample was taken in petri dish and baited with keratinous substances. Baits used were cut into pieces of 1-2 cm and autoclaved for 20 minutes at 15 lbs pressure. Baits were kept directly on effluent aseptically in the petri dishes. Petri dishes were incubated at $28 \pm 1^\circ\text{C}$ in BOD incubator. Fungi coming up in cultures were identified using standard texts. Isolates were raised from single spore through dilution method to ensure purity of cultures. Cultures were deposited in the culture collection of the Bio-pollution Study Centre, Christ Church College, Kanpur.

Dermatophytes are described as a fungus leading a

parasitic life on skin, hair or nail or man or other animals (Ainsworth, 1964). Keratinophilic fungi and dermatophytes from tannery effluent have been reported for the first time. Two genera spread over 7 species were isolated during present investigation. *Chrysosporium indicum*, *Chrysosporium tropicum*, *Chrysosporium pannicola* and *Chrysosporium evolveanui* were prominent. Other commonly isolated fungi were *Chrysosporium carmichaeli*, *Chrysosporium lucknowense* and *Arthroderma gertleri*.

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